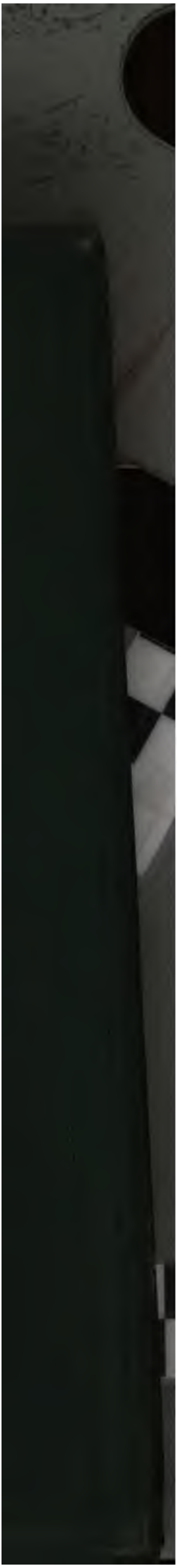

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AMERICAN GAS LIGHT ASSOCIATION.

REPORT OF PROCEEDINGS

OF THE

ANNUAL MEETING HELD AT CINCINNATI, O.,

OCTOBER 17TH, 1877.

AND

ANNUAL MEETING held at NEW YORK CITY, N. Y.

OCTOBER 15TH 1878.

OCTOBER, 1879.

PUBLISHED BY THE AMERICAN GAS LIGHT ASSOCIATION.

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The American Gas Light Association and its several members are indebted to the courtesy of the *American Gas Light Journal* for Stenographic Reports of the proceedings of the Association, gratuitously furnished for publication in this volume.

CHARLES NETTLETON,
Secretary

CONTENTS.

V.

DISCUSSIONS.

AMERICAN GAS LIGHT ASSOCIATION.

REPORT OF PROCEEDINGS,

ETC., ETC.

FIFTH ANNUAL MEETING OF THE AMERICAN GAS LIGHT ASSOCIATION,

HELD AT CINCINNATI, OHIO, OCTOBER 17, 1877.

The Convention assembled at 10 o'clock, A. M. and was called to order by Second Vice-President, George B. Neal, of Charlestown, Mass., the President, Gen. Roome, and the First Vice-President, W. H. Price, both being absent on account of illness; the former being in poor health himself, and the latter being unable to leave home on account of the illness of his principal assistant and serious illness in his family.

MR. NEAL'S REMARKS.

Upon calling the meeting to order Mr. Neal said:

GENTLEMEN OF THE ASSOCIATION:—The time for which this meeting was called is now past, the time was fixed at 10 o'clock A. M., it is some few minutes past that time now, and you will please come to order. I hope the members, as they come into the Hall, will come forward and take seats as near the platform as possible, and endeavor to be as quiet as possible, for there is quite an echo here, which makes it somewhat difficult to hear. I regret very deeply to have to announce to the meeting that our veteran President, General Roome, will be absent on account of ill-health. In his absence the charge of the meeting devolves upon Mr. Price, of Cleveland, our First Vice-President, he was notified by the Secretary that General Roome would be absent, and was also requested to prepare an address, and I suppose he did prepare an address; he intended to be here, but last evening, upon our arrival from the East, the Secretary

received a telegram from Mr. Price, stating that he had intended to be present, but owing to sickness in his family, he would be prevented from attending, and said in his telegram that he would write.

I think, that in the absence of General Roome, Mr. Price would have adorned this position, and have filled it much better than myself, and he had, no doubt, prepared an address which would interest you. I suppose the members are expecting an address from the President; the rules seem to require that an address shall be made by the President, but it says nothing about the Vice-President. In the absence of the President and First Vice-President, the duty of presiding over this meeting devolves upon the Second Vice-President. I should have much preferred to occupy a seat on the floor rather than to hold this honorable and responsible position on the platform as President. I am not much accustomed to presiding at meetings; but I think I shall be assisted in conducting the discussions of this meeting, by the members of the Association.

We meet here for mutual improvement; we have in charge a specialty which involves the interests of the public, and we do not meet here as a combination—a combination to raise prices. We meet here to discuss questions connected with the manufacture and distribution of gas. The aim of Gas Companies now generally is not to earn and pay large dividends, but to earn and pay a fair profit on their outlay, and it is the aim of the companies—the officers and engineers of the companies—to reduce the cost of gas, so that the price may be reduced to the consumers, and we are ready to receive anything that will tend to effect that object. It has been said by some people that we are unwilling to adopt anything new by which the cost of gas will be lessened. That is very untrue. We are willing to receive anything that will reduce the cost of gas, so that the price may be reduced to the consumers.

But, as I have prepared no address, and as we have considerable business before us at this session, I will proceed to business.

I hope the gentlemen will bear with me, and if I make any mistakes, as your presiding officer, in the rules, that you will

not criticise them strongly, but assist me as much as lies in your power. I hope the members, when they rise to take part in the discussions, will address the chair, and that only one member will endeavor to speak on the same subject at a time; for, if that is done, the reporter can hear what you have to say, and the report will be much more satisfactory.

The first thing in order, as you will see by turning to the rules on the eighth page of the pamphlet, is the reading of the minutes of the last meeting. What is your pleasure with regard to that?

MR. HENRY CARTWRIGHT—I move that the redding of the minutes of the last meeting be dispensed with, because they are already published, and in the hands of the members.

This motion was unanimously carried, and the President called the next order of business, which was the reading of applications, notices and reports for new membership.

The following applications for membership were handed in to the Secretary:

Miles W. Caughey,	Erie, Pa.
F. M. Root,	Connersville, Ind.
Wm. Poland,	Chillicothe, Ohio.
E. D. Moore,	Circleville, Ohio.
Wm. A. Steadman,	Newport, R. I.
H. F. Gerould,	Cairo, Ill.
Lazarus Noble,	Vincennes, Ind.
T. A. Bates,	Evansville, Ind.
Wm. Gibson,	Cambridge, Mass.
C. E. Gray,	St. Louis, Mo.
Thos. A. Cosgrove,	Chicago, Ill.
Gilliard Dock,	Harrisburg, Pa.
Hugh Murphy,	Sing Sing, N. Y.
Kerr Murray,	Fort Wayne, Ind.
Joseph O. King,	Jacksonville, Ill.
R. C. Terry,	Philadelphia, Pa.
Wm. Heilman,	Evansville, Ind.

THE PRESIDENT—Gentlemen, you hear the names proposed for membership, and also the certificates; what is your pleasure?

A MEMBER—I move that the Secretary be instructed to cast the ballot of the Association for the gentlemen named.

The chair appointed as tellers Mr. White, of Brooklyn, and Mr. Gerdenier, of Bridgeport. The tellers reported the unanimous vote of the Association in favor of admitting the gentlemen to membership, and they were accordingly declared duly elected as members.

THE PRESIDENT—The next thing in order is the introduction of new members. They will please stand up. The new members arose, and the Secretary said—

It gives me great pleasure to receive you as members of our fraternity, and without more words I am very happy to introduce you to the members of the Association. (Applause).

THE PRESIDENT—The next thing in order, according to the programme, is the address of the President. Those of you who were present at the opening of the meeting, heard my remarks to the effect that General Roome was prevented from being present by illness, and that a telegram was received last night from Mr. Price, stating that he would be prevented from being here, and hence the duty devolved upon me to preside. I have prepared no address, as I had no time to do so, and it would be impossible for me to do so if I had had time. My sleep was very much broken last night, for causes which would have been apparent to any one present. (Cheers and laughter.) I am sorry Mr. Price is not present, as he had prepared an address.

The next thing in order is the report of the Executive Committee, which, according to the Constitution, is composed of all the officers of the Association, and the Executive Committee, which is rather an anomoly. I will call upon Mr. Denniston, of Pittsburgh, Chairman of the Committee, to make the report.

MR. DENNISTON—The Executive Committee have very little to report. There being no semi-annual meeting, there was but very little to do ; but we beg leave to offer the following :

REPORT OF EXECUTIVE COMMITTEE.

To the Officers and Members of the American Gas-Light Association.

There being no semi-annual meeting there has been but very little for your Executive Committee to do.

We beg leave to submit for your consideration the following—

Resolved, That we extend an invitation to the Board of Directors of the Cincinnati Gas-Light and Coke Company to attend the sessions of the Association in Cincinnati; and that the Secretary be authorized to invite any and all officers or directors of gas companies, visiting in the city to attend the sessions the same as if introduced by a member. Adopted.

Resolved, That all matters relating to forfeited membership be referred to the Executive Committee, with power to act, and the Secretary be directed to notify all members in arrears. Adopted.

Resolved, That the Executive Committee recommend the appointment of a committee to take into consideration the subject of statistics of gas manufacture from the gas companies for tabulation. Adopted.

The following members were appointed such committee:

Geo. A. McIlhenny, Henry Cartwright, and A. B. Slater.

Resolved, That the members have two copies of the report of proceedings of Volume II. free of charge. Adopted.

Resolved, That the members of the Association have the right to purchase additional copies of Volume II., at the cost of $1.25 each. Adopted.

Resolved, That the Association purchase the one hundred additional copies of Volume II. of the proceedings, printed for the Secretary on his own personal responsibility. Adopted.

Resolved, That the salary of the Secretary and Treasurer for the current year be the same as last year. Adopted.

We also recommend the reading of the following papers:

MR. SHERMAN—On "Some of the Reasons why Gas Consumers should not favor Competition in its Supply."

MR. FORSTALL—On "Dispensing with Dip Pipe in Hydraulic Main."

BENJ. RANKIN.—On "Carbonizing Coals."

THOS. CURLEY—On "Naphthaline."

CAPT. DRESSER—On "Naphthaline."

J. D. PATTON—On "Uniform Price of Gas."

FREDK. S. BENSON—On "Temperature of Retorts."

We also offer the following general order of business:

Meeting at 10 A. M., 17th inst.
" at 3 P. M., "
" at 7.30 P. M., "

Meeting at 9 A. M., 18th inst.

18th inst., at 11 A.M., the Convention is to be received as the guests of the Cincinnati Gas Light Company.

THE PRESIDENT—You hear the report of the Executive Committee. What action will you take on it?

MR. MCILHENNY moved that the report be accepted as a whole, and the resolutions contained therein adopted. Carried.

THE PRESIDENT—The next thing in order is the report of the Treasurer, which, I suppose, will be very interesting of course.

Before hearing the report of the Treasurer, Mr. Denniston said:

I desire to call the attention of the Association to the fact that those who have not paid their annual dues are not entitled to a vote in the Convention, and I want to pay my $5, so that I can vote.

On motion a recess of five minutes was taken to allow the members to pay their dues, and at the conclusion of the recess the President said:

Now, gentlemen, you will please be seated as near the platform as possible. I suppose you are now ready for business, and the next thing in order is the report of the Treasurer, and the report of the Finance Committee, I suppose will be included in that report, as the two come together.

Mr. Nettleton, the Treasurer, then reported as follows:

TREASURER'S REPORT.

Cash on hand last report	$365.97	
" Rec'd. for initiation fees	200.00	
" " " dues	755.00	
" " 8 copies proceedings sold (7 vol. 2 and 1 vol. 1)	15.40	
Total	$1,336.37	
Cash paid for—		
Sundries	$ 60.90	
Printing	631.15	
Hall rent, last meeting	100.00	
Hoffman House parlor last meeting	20.00	
Refund of initiation fee	5.00	
Salary Sec. and Treas.	350.00	
Total	$1,167,05	
Cash Balance on hand—		$169.32

There are 189 names on the roll of the Association. Three of the 189 have died, viz., Charles Collier, of Selma, Alabama, died in May, 1876; G. T. Sutton, of Peekskill Gas-Light Company, died in April, 1876; and W. H. Perry, of Bangor, Maine, died in May, 1877.

Mr. Wood, of Syracuse, moved that the Treasurer's report be received, and referred to the Finance Committee, which was carried.

Mr. Chambers, chairman of the Finance Committee, stated that the Committee had examined the Treasurer's report, together with the accounts and vouchers, and had found them

correct; whereupon Captain White moved that the report of the Finance Committee be received and accepted, which was carried

THE PRESIDENT—The next thing in order is the reports of special committees.

CAPTAIN WHITE—Mr. Chairman; as a member of the committee appointed at our last meeting in New York to prepare the proceedings of this Association for publication, I have to report as follows.

REPORT OF COMMITTEE ON PRINTING PROCEEDINGS.

To the Officers and Members of the American Gas-Light Association:

GENTLEMEN: Your committee having charge of the publication of the proceedings of the Association from May, 1875, to October, 1876, inclusive, beg leave to report that they have performed the duty entrusted to them; having carefully, and, they trust, impartially, revised the report of proceedings placed in their hands by the Secretary of the Association. Asked proposals to publish from several responsible parties, and, after due consideration of the bids received, awarded the contract for publication of the report—500 copies—to the Case, Lockwood & Brainard Company, of Hartford, Conn., for the sum of five hundred (500) dollars, the books to be delivered in New York city. After the contract was awarded some additional matter was introduced in the report, and an additional expense of $81.45 incurred, making the total expense of publication $581.45.

Your Committee submits the printed copy of proceedings, that has been mailed to each member, as the practical result of their labors (a labor at once delicate and onerous) in the earnest hope that the duty entrusted to them has been performed with care and discretion, and will receive the approbation of the Association. All of which is, respectfully, submitted.

Committee: CHAS. ROOME.
CHAS. NETTLETON.
WM. HENRY WHITE.

Captain White—I would say, in addition, that the duties connected with this committee have been onerous and delicate. Many gentlemen have made remarks here that they expected to see in print, but the instructions to us were such that we were only permitted to publish such things as were necessary to give absent members a correct idea of the work done. Many pleasantries, which added greatly to the enjoyment of the meeting, were necessarily stricken out; but we have retained all that we considered as necessary to constitute a suitable memorial of the business transactions of the meeting.

The President—Gentlemen, you hear the report of the committee upon publication of the proceedings of the Association. You have the work before you, and I think it does credit to the committee. I think it is a valuable book, and will tend to show to members of the gas fraternity, not members of the Association, that there really is something in the Association.

Mr. Floyd moved that the report of the committee be accepted, that the thanks of the Association be proffered the committee, and that the committee be discharged, which motion was carried.

The President—I understood from Captain Dresser that there was a committee appointed to report upon the best method of calculating leakage—to whom was that subject referred?

The Secretary—There was a special committee on that subject; but Mr. Farmer, a member of that committee, who was expected to report, is not here, so that the committee are not just now prepared to report, and they ask for a little further time, and will report during the session.

Before proceeding to further business there is one other matter I wish to mention. Mr. William King, Engineer-in-Chief of the Liverpool Gas Company, England, has been on a visit to this country, and was here until last Saturday, when he left for England, the President and your Secretary giving him an invitation to be present here as the guest of the Association. To that invitation he sends this letter in reply:

MR. KING'S LETTER.

NEW YORK, October 10, 1877.

"Gentlemen : On my arrival here I found your very kind invitation, on behalf of the American Gas-Light Association, that I should become their guest during the approaching Annual Meeting, to be held in the city of Cincinnati, on the 17th inst.

"Permit me to tender to you my warmest thanks for this mark of your consideration. Had time permitted I should most gladly availed myself of your kindness ; but, unfortunately business requires me to leave this country, on Saturday next, for England, and I am, therefore, deprived of the privilege of attending the meeting ; and, consequently shall lose, I feel sure, much valuable and interesting information.

"I desire to take this opportunity of thanking the members of the profession in those cities which I have visited, during my tour in this country, for the very great kindness and attention I have received from them.

"Wishing that continued success may attend the operations of your Association, I have the honor to be,

Yours Very Faithfully,

WILLIAM KING.

GEN. CHAS. ROME, *President*,

CHAS. NETTLETON, Esq., *Secretary*,

American Gas-Light Association.

I will say that Mr. King, personally, asked me to present his kindest wishes and regards to the Association, in addition to this written acknowledgement of our invitation.

MR. DENNISTON—I move that the communication be received, placed upon file, and spread upon the minutes so that it will appear in the publication.

This motion was carried, and there being no further reports from special committees, the President stated that the Association would proceed to the election of officers for the ensuing year.

MR. HENRY CARTWRIGHT—I move that a committee of five be appointed by the Chair, to nominate a list of candidates for the offices named in the Constitution, the committee to report as soon as possible. The motion was carried, and the following named gentlemen were named by the President—

Mr. Henry Cartwright, Mr. A. C. Wood, of Syracuse, Capt. White of Brooklyn, Mr. Coggshall of Pittsburg, and General Hickenlooper, of Cincinnati.

General Hickenlooper, upon request, was excused on account of his time being so fully occupied with other matters, and the President appointed in his place Mr. Littlehales, of Canada.

MR. DENNISTON—I noticed from the report of the Secretary that one or more deaths have occurred. It is customary to appoint a committee to report appropriate resolutions upon the death of members, and I now move that the Chair appoint a committee of three to prepare and present to the Association suitable memorials. The motion was carried, and the Chair named as the committee, Mr. Dunbar, of New Albany, Indiana, and Colonel Stedman, of Newport, Rhode Island.

Mr. FORSTALL moved that the roll be called, which was carried; and the following gentlemen responded to their names when called by the Secretary.

MEMBERS PRESENT.

John Andrew,	Chelsea, Mass.
Isaac Battin,	Albany, N. Y.
Fred. S. Benson,	Brooklyn, N. Y.
Wm. H. Baxter,	Petersburg, Va.
T. A. Bates,	Evansville, Ind.
Thos. Butterworth,	Rockford, Ill.
Matt. Cartwright,	Rochester, N. Y.
H. F. Coggshall,	Fitchburg, Mass.
N. B. Crenshaw,	Philadelphia, Pa.
Henry Cartwright,	" "
John Cartwright,	Poughkeepsie, N. Y.
John S. Chambers,	Trenton, N. J.
Wm. Cartwright,	Oswego, N. Y.
Thos. A. Cosgrove,	Chicago, Ill.

Samuel A. Dickey, . .	Dayton, Ohio.
W. H. Denniston, . .	Pittsburg, Pa.
Wm. Dunbar, . .	New Albany, Ind.
M. N. Dial, . . .	Terre Haute, Ind.
Gilliard Dock, . .	Harrisburg, Pa.
Jas. R. Floyd, . . .	New York City.
Theobald Forstall, . .	New Orleans, La.
F. W. Gates, . . .	Hamilton, Ont.
L. P. Gerould, . .	Newton, Mass.
A. G. Guerard, . . .	Savannah, Ga.
Wm. Gardner, . .	Pittsburg, Pa.
Chas. A. Gerdenier, . .	Bridgeport, Conn.
W. W. Goodwin, . .	Philadelphia, Pa.
H. F. Gerould, . . .	Cairo, Ill.
Wm. Gibson, . .	Cambridge, Mass.
C. E. Gray, . . .	St. Louis, Mo.
L. C. Hanford, . .	Norwalk, Conn.
A. Hickenlooper, . .	Cincinnati, Ohio.
Wm. Helme, . .	Atlanta, Ga.
Thos. C. Hopper, . .	Clarksville, Tenn.
M. Harrington, . .	Niagara Falls, N. Y.
Wm. Heilmann, . . .	Evansville, Ind.
Joseph O. King, . .	Jacksonville, Ill.
T. Littlehales, . . .	Hamilton, Ont.
J. Linton, . . .	Ravena, Ohio.
Edward Lindsley, . .	Cleveland, Ohio.
J. H. McElroy, . .	Pittsburg, Pa.
Geo. A. McIlhenny, . .	Washington, D. C.
Emerson McMillis, . .	Ironton, Ohio.
Richard J. Monk, . .	Boston, Mass.
C. F. Maurice, . .	Sing Sing, N. Y.
Lewis Moss, . . .	Sandusky, Ohio.
W. H. Miller, . .	Columbus, Ohio.
E. D. Moore, . . .	Circleville, Ohio.
Hugh Murphy, . .	Sing Sing, N. Y.
Kerr Murphy, . . .	Fort Wayne, Ind.
Geo. B. Neal, . .	Charleston, Mass.
Charles Nash, . . .	Williamsport, Pa.
Chas. H. Nettleton, . .	Derby, Conn.

Chas. Nettleton, . .	New York city.
Lazarus Noble, . .	Vincennes, Ind.
Willard Parritt, . . .	Bloomington, Ill.
T. J. Pishon, . .	Roxbury, Mass.
Samuel Prichitt, . .	Nashville, Tenn.
Albert D. Perry, . .	Portsmouth, Va.
W. H. Pearson, . .	Toronto, Canada.
Eugene Printz, . . .	Zanesville, Ohio.
Wm. Poland, . .	Chillicothe, Ohio.
Benjamin Rankin, . .	Louisville, Ky.
J. H. Rollins, . .	Worcester, Mass.
Geo. Richardson, . .	Wilmington, Del.
H. J. Reinmund, . .	Lancaster, Ohio.
James F. Rogers, . .	Jamaica Plains, Mass.
F. M. Root, . . .	Connorsville, Ind.
A. B. Slater, . . .	Providence, R. I.
Marcus Smith, . .	Wilkes Barre, Pa.
James Somerville, . .	Knoxville, Tenn.
Jas. M. Starr, . .	Richmond, Ind.
Jas. K. Smith, . . .	Newark, Ohio.
F. C. Sherman, . .	New Haven, Conn.
Henry Stacey, . . .	Indianapolis, Ind.
Wm. A. Stedman, . .	Newport, R. I.
Thomas Turner, . .	Charleston, S. C.
R. C. Terry, . .	Philadelphia, Pa.
C. White, . . .	Rochester, N. Y.
W. Henry White, . .	Brooklyn, N. Y.
R. M. Wilder, . . .	Coldwater, Mich.
Austin C. Wood, . .	Syracuse, N. Y.
Geo. H. Wells, . . .	Nashville, Tenn.
Geo. H. Walworth, . .	Cleveland, Ohio.
Robert Young, . . .	Alleghany City, Pa.

MR. BURTIS, of Chicago, said: Mr. Chairman; the president of my company has sent me in his stead, and I would like to know whether our company will be allowed to have a representation here or not. The Secretary has not read the name of our president, who was not able to be present, and sent me here in his stead, not knowing, I suppose, that there would be any dif-

ference whether he attended himself or sent some one in his place ; and I want to know whether the company will be disfranchised because the name of the president does not appear as a member, nor is my own name on the roll as a member. Of course, I don't wish to be here if I am not entitled to a seat in the Convention.

THE PRESIDENT—As I understand this matter, the Association, by a vote, passed an amendment to the constitution in which it was decided that individuals should be members and not companies—that individuals do not represent companies. They appear generally as individuals; but the companies, in most cases, pay their expenses whatever they may be. In my own case I am here as an individual, although the Charlestown Gas Company pay for the fee of membership and all reasonable expenses. If I were not able to be present, and the President should attend, I should not consider that he had any more right to vote than a stranger. I don't see how the power can be delegated, and the chair will rule that such is the meaning of the constitution.

MR. HENRY CARTWRIGHT—In order to test the sense of the meeting, and at the same time appeal from the Chair. I will make a motion that Mr. Burtis be received here as a substitute in place of Mr. Watkins, president of his company, with all the powers and privileges that he would be entitled to if he were here himself.

THE PRESIDENT—The Chair ruled that, in his opinion, Mr. Burtis was not competent as a member of the Association in place of the gentleman whose name was furnished from the company. I have no feeling in the matter of course ; and it remains for the members of the Association to say whether or not he shall be considered as entitled to the rights of membership.

MR. FLOYD—I believe the question is now whether the chair shall be sustained or not.

MR. WOOD, of Syracuse, asked for the reading of Article IV. of the constitution before the vote was taken.

His request was complied with, after which the vote was

taken, and the decision of the chair sustained; the President having stated, in the meantime, that the difficulty was removed from before the Association by Mr. Burtis having offered his own name as a member.

A MEMBER—I move that the courtesy of the Association be extended to Mr. Burtis, and that he be asked to remain with us during our deliberations.

THE PRESIDENT—I will read a resolution of the Executive Committee, which, I think, covers this and all other cases of a similar nature.

Resolved, That we extend an invitation to the Board of Directors of the Cincinnati Gas-Light and Coke Company to attend the sessions of the Association in Cincinnati; and that the Secretary be authorized to invite any, and all, officers or directors of gas companies, visiting in the city, to attend the sessions the same as if introduced by a member.

THE SECRETARY then said: If there are any officers of the Cincinnati Gas-Light Company, or of any other gas company in the world, present here to-day, they are invited to take part in its discussions. I cordially extend this invitation on behalf of the Association. (Cheers.)

THE PRESIDENT—Is the committee on nominations prepared to report?

MR. CARTWRIGHT, the chairman of the committee, made the following report:

REPORT OF COMMITTEE ON NOMINATIONS.

The Committee on Nominations respectfully report the following persons for election as officers of the coming year:

President:	GEN. CHAS. ROOME, New York.
Vice-Presidents:	W. H. PRICE, Cleveland, Ohio. GEO. B. NEAL, Cambridge. T. LITTLEHALES, Hamilton, Ont.
Secretary and Treasurer:	CHAS. NETTLETON, New York.
Finance Committee:	JNO. S. CHAMBERS, Trenton. J. P. HARBISON, Hartford. GEO. A. MCILHENNY.

Executive Committee:

W. H. Denniston, Pittsburg.
F. C. Sherman, New Haven.
A. Hickenlooper, Cincinnati.
Henry Cartwright, Phila.
W. H. White, New York.
Henry Stacey, Indianapolis.

Upon motion, the report was received, when Mr. White, of Rochester, moved that the Secretary be authorized to cast a ballot, on behalf of the Association, for the gentlemen named in the report; and, there being no objection, the motion was declared carried.

Mr. Noble arose and said: Inasmuch as there is but one person in nomination for each office, I move that the formality of casting a ballot be dispensed with, and the nominees be declared unanimously elected.

The Chair decided the motion out of order, stating that the constitution prohibited the dispensing with the ballot, and Captain White and Mr. Slater were appointed as tellers; the ballot was cast, and the gentlemen named in the report declared duly and unanimously elected to the offices for which they were nominated by the committee.

The President—The reading of papers is now in order, and the first one is by Mr. Sherman of New Haven, Conn.

Mr. Sherman said: The subject which I have chosen is one of considerable importance to every member of the Association. It consists principally of extracts from the opinions of those who oppose competition in gas companies; and if it shall be the means of disseminating information upon that subject, I shall feel more than repaid for any labor that I have bestowed upon it. My friend, Captain Dresser, has kindly consented to read my paper for me.

SOME OF THE REASONS WHY GAS CONSUMERS SHOULD NOT FAVOR COMPETITION IN ITS SUPPLY.

We are often asked why our business should be a monopoly. Competition is good; why should it not exist here as in any kind of trade? In regard to many branches of trade there is no absolute limit in regard to the business that they can do, or

the amount of consumption. The consumption of gas is limited. There never has been any objection to any man's making his own gas, or to any number of persons uniting together to make gas for themselves, provided their business affects their own private rights. It is only when certain public rights, *i. e.*, to dig up the public streets, and to lay pipes in them, and to use the pipes and the streets for distributing gas, that any objection can be made.

When any right is withdrawn from the public in general, it becomes a monopoly, and remains so, whether the right is granted to one or to six. The right to occupy the same streets with pipes must of necessity be limited because there is not room enough; it is a physical impossibility for everybody to do it. The injury done to streets by excavations for sewers, water and gas pipes, is very great. When you once break the ridge of a paved street it is a broken street ever after, unless it is relaid. The actual interference with the streets will be by two competing companies, nearly doubled. The leakage from gas pipes laid in the streets is another important consideration. All know the poisonous effects of gas upon animal and vegetable life, and upon water. From a sanitary point of view the distribution of gas in the public streets is a nuisance, and should be restricted to the actual needs of the gas consumers. The interference of new mains, with those already laid, will increase the leakage, and the escape of gas into the sewers and water pipes will be increased. If there be two sets of pipe in the same street it will not always be easy to determine where the fault lies, in case of a leak; which company is to make the excavation. Whose leak is it? While the two companies are disputing as to who shall do the digging, immense damage may be done to property, and, perhaps, to life. What means are there of determining? Those pipes run through the street side by side; whose pipe is it that leaks? And if one company digs down to find the leak, and it turns out to be in the pipes of the other company, then the first company will shove the earth back, fill up the holes, and the other company must go to work and dig it out again. The annoyance and trouble that would follow, from having two organizations undertake to do the same work, in the same place, are infinite in number.

If you have in any business sufficient capital embarked to do that business, thoroughly and properly, it is perfectly clear that if you put in additional capital the cost of the product must be increased to the consumer. If the facilities of supplying a city are equal to its needs, how can you diminish the price by doubling those facilities. If one pipe laid in a street is sufficient to furnish gas to all consumers on that street, how will you cheapen the price of gas to those consumers by laying an additional pipe? John Stuart Mill, who is high authority on political economy, writing of competing gas and water companies, says:

"When, in any employment, the regime of independent small producers has either never been possible, or has been suspended, and the system of many workpeople under one management, has become fully established, from that time any further enlargement in the scale of production is generally an unqualified benefit. It is obvious, for example, how great an economy of labor would be obtained if London were supplied by a single gas or water company, instead of the existing plurality. While there are as many as two, this implies double establishments of all sorts, when one only, with a small increase, could probably perform the whole operation equally well; double sets of machinery and works, when the whole of the gas or water required could generally be produced by one set only; even double sets of pipes, if the companies did not prevent this needless expense, by agreeing upon a division of the territory. Were there only one establishment, it could make lower charges consistently with obtaining the rate of profit now realized. But would it do so? Even if it did not the community in the aggregate would still be a gainer, since the shareholders are a part of the community, and they would obtain higher profits, while the consumer paid only the same. It is, however, an error to suppose that the prices are even permanently kept down by the competition of these companies. Where competitors are so few, they always end in agreeing not to compete. They may run a race of cheapness to ruin a new candidate, but as soon as he has established his footing, they come to terms with him. When, therefore, a business of real public importance can only

be carried on advantageously upon so large a scale as to render the liberty of competition almost illusory, it is an unthrifty dispensation of the public resources that several costly sets of arrangements should be kept up for the purpose of rendering to the community this one service. It is much better to treat it at once as a public function; and if it be not such as the government itself could beneficially undertake, it should be made over entire to the company or association which will perform it on the best terms for the public."

I might rest my argument upon this paragraph from J. Stuart Mill, because he has put it in such a concise manner that it settles the question in my mind. But I will quote further, in the same line of argument, from President C. O'Donnell, of the Baltimore Gas-Light Company:

"Competition is a taking word, because in almost all cases it means progress and public good. There are exceptions to this rule, as to all rules. There are some things in which competition is impossible. Competing water companies are manifestly impossible. And in proportion as the subject to be competed in approaches a public character, this competition becomes impossible. Competition thrives where the price increases the demand and supply. This fundamental element is wanting in gas supply. One gas pipe in a street will light just as many houses as two pipes. The number of consumers is a fixed quantity, in every street limited by the number of houses, and the competition of rival gas companies is simply to expend double the necessary capital in doing the same thing.

"If it should actually happen, after some citizens had invested two millions of dollars in extending mains in all the streets, bringing gas to every house, others should expend an equal amount in laying down another set of pipes in all the streets, there is a waste of capital of two million dollars, in doing something which is already done, and which, when done over again, will supply no more gas, light no house not already lighted. Competing railroads and steamboats increase the means of locomotion; they enable more people to travel, and to travel more frequently; they transport freight lacking means of transportation. Yet, competing railroads and steamboats

ON THE ADVANTAGE OF REMOVING THE HYDRAULIC SEAL DURING THE DISTILLATION OF COAL.

By Theobald Forstall, New Orleans.

The advisability of leaving clay retorts from all pressure during the process of distillation, has been for years discussed by gas engineers on both sides of the Atlantic. The experiments of Grafton have been generally considered as proving conclusively that the deposition of carbon was due to pressure only; and numberless methods have been contrived and patented for the purpose of completing the efficacy of the exhauster, by removing the hydraulic seal entirely while the charges are working off.

Mr. McIlhenny, of Washington, was, I think, the first to adopt this system of distillation, in the United States. His method of removing the seal was described by himself in a paper read in October, 1873, at the first annual meeting of the Association. His example was soon followed in many gas works; but, although several years have elapsed since the system was thus put into practical operation, I have seen no published records of the actual benefits derived from it, except such as were merely experimental, extending over a few days or weeks only. I propose, therefore, in this paper, to lay before you the results obtained by the exclusive use of unsealed dip-pipes, during three years continuously, in the New Orleans gas works. Although I have no very startling statements to submit, I trust that the communication will be of interest, if only as an *accurate record of retort-house experience.*

The advantages which were expected to follow the removal of the hydraulic seal, stated in the order of their importance, were:

1st. Increased production of gas per pound of coal.

2d. Entire prevention of carbon deposits in the retorts.

3d. Greater durability of the retorts.

We may determine from the facts stated below how far each of these advantages has been realized.

The system of carbonization in the New Orleans works has passed through three distinct phases since my first connection with the company. During the first period, ending in June, 1871, the retorts were worked at a low red heat, against a hydraulic seal of four inches. The exhauster was employed merely to overcome the resistance of the purifiers and gas-holders; the retorts being left under the full pressure of the hydraulic seal and of the scrubbers; and this pressure, from numerous observations with the gauge applied to the mouth-piece, was found to pulsate violently from a minimum of four to a maximum of seven inches.

The second period extended from June, 1871, to May, 1873. The heats were raised to an orange color; the hydraulic seal was lowered to 1.25 inches, and the exhauster regulated to maintain a vacuum of one inch in the main, so as nearly to counteract the seal. We had expected in this manner to relieve the retorts from all pressure, but the real effect was anything but this, and first opened my eyes to the mischievous action of the dip-seal. Repeated observations with the gauge showed, that with a perfectly steady vacuum of one inch in the hydraulic main, the actual pressure in the retorts was ever varying throughout the whole duration of a charge. The range at the beginning was often from a *vacuum* of 3.5 to a *pressure* of 3.5 inches; the oscillations being very rapid and violent, but gradually diminishing towards the end of the charge until the range was from .5 to 1.5 inch pressure. A table of one series of these observations is here inserted:

Table of Pressures observed in Retorts under the influence of the Hydraulic Seal.

Depth of Seal 1.25 inches. Pressure in Hydraulic Main steady at —.8* inch during all the observations.

	Time after Retorts were charged. Hrs Min	Range of Oscillations of Pressure in inches.	Remarks.
Bed No. 17. Retort No. 1.	.05	—2.0 to 2.6	Oscillations of gauge very rapid and violent during all the trials.
" "	1.30	—1.0 " 1.4	
" "	3.45	.4 " 1.0	
" No. 2.	0.5	—2.4 " 3.6	
" "	1.30	.4 " 1.6	Stand-pipe partially obstructed.
" "	3.45	.6 " 1.6	" " " "
" No. 3.	.05	—3.2 " 4.0	
" "	1.30	—1.8 " 1.8	
" "	3.45	.6 " 1.0	
" No. 4.	.05	—3.4 " 3.4	
" "	1.30	—2.0 " 2.0	
" "	3.45	.6 " 1.4	Stand-pipe partially obstructed.
" No. 5.	.05	—1.8 " 2.4	
" "	1.30	—2.2 " 2.2	
" "	3.45	.6 " 1.4	
Bed No. 18. Retort No. 1.	.10	—1.0 " 2.1	
" "	1.00	—1.0 " 2.1	
" "	1.30	— .8 " 2.4	
" "	2.00	— .8 " 2.4	
" "	3.00	.5 " 1.5	
" "	3.30	.5 " 1.5	
Bed No. 19. Retort No. 2.	.10	—1.2 " 2.4	
" "	1.45	—1.0 " 2.4	
" "	3.00	— .6 " 2.4	
" "	3.45	1.0 " 2.5	
" No. 4.	.10	—2.0 " 3.2	
" "	1.45	—2.0 " 3.2	
" "	3.00	—1.2 " 2.4	
" "	3.45	2.0 " 2.5	Stand-pipe partially obstructed.

*The minus sign (—) is used to express negative pressure or vacuum.

The third period began May 17, 1873, ending in 1876, with the dismantling of the retort-house in which these operations were carried on, and the starting of new works. The heats were kept at a bright orange, but the weights of charges somewhat reduced. Every bed of retorts was provided with a pneumatic apparatus for removing the hydraulic seal, invented by H. H. Edgerton, Esq., of Fort Wayne, in which all the objections that I had found to exist in previous methods of accomplishing the same end were completely removed; and which I should like to describe and to praise here as it deserves, if it were not outside the object of my paper. The exhauster was now regulated to draw the gas from the retorts in a steady flow, keeping a constant pressure of .3 to .5 inch within these vessels.

During the whole of these periods the retorts used were of the same shape and dimensions (D form, 12 by 20 inches, and 9 feet long), most of them from the same makers, and of similar quality. They were set in beds of five, principally on Sabbaton's plan, and were fired and charged by the same stokers, on the four hour system. The coal used was Pittsburg (or Youghiogheny) exclusively, without Cannel or other enricher. Tables A, B and C exhibit the result of each of the three periods under appropriate heads. The individual record of each bed is not given for the first period, except as regards the number of days under fire; because at that time the weight of the coal daily carbonized by each setting was not separately registered; but the totals have been accurately established for this period, from the actual weights charged in the whole number of retorts included in the investigation, during their respective terms of action. For the two latter periods, the exact weight of coal carbonized by each setting daily, was recorded, and the totals given are the weights for each bed. In the recapitulation I have added a column of percentage of fuel used, in anticipation of possible questions on this point, although not bearing directly upon my subject.

Before calling your attention to the lesson conveyed by the tables, it may be well to formulate the governing principle underlying the different methods of working pursued during each succeeding period. This may be stated as follows:

In the first period : To save the retorts from harm as much as possible, at the cost of diminished production of gas, under a vague idea that the gain on the one side would cover the loss on the other. The manager in charge at that time was a practical gas maker, not given to figures.

In the second period : To get all the gas out of the coal, leaving the retorts to the chances of a short but glorious existence.

In the third period : To keep up the yield of gas, improve its illuminating power, and save the retorts at the same time.

A. **FIRST PERIOD.** 1868-1871.

Record of Performance with 20 Beds, of 100 Retorts, 12 by 20 Inches.

These Retorts were worked at low red heats, with Hydraulic Seal of four inches. Actual Pressure in Retorts four to seven inches.

Number of bed	9	10	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Days under fire	393	596	928	819	762	647	687	892	842	821	731	732	587	622	670	671	687	701	693	769
Number of times cooled down	0	0	2	2	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1

Total Days under fire	14,250
Mean " " "	712½
Total Coal Carbonized—lbs	83,332,000
Mean " "	4,166,600
Total Charges Missed while Clearing of Carbon in lbs. of Coal	3,566,600
Mean " " " " " " "	178,330=4.28 per cent.
Average weight of Coal Carbonized per bed per day	5,852
Average charge per Retort, every four hours	195
Average production of Gas per Retort daily—cubic feet	4,960
Average Yield per lb. of Coal—cubic feet	4.24
Total production of Gas—cubic feet	353,330,000
Mean " " "	3,533,300

B. SECOND PERIOD. 1871-1873.

Record of Performance of 15 Beds of 75 Retorts, 12 by 20 Inches.

These Retorts were worked at bright orange heat, with Hydraulic Seal of 1.25 inches. Actual Pressure in Retorts ranging from—3.5 in. minimum to 3.5 in. maximum.

Number of Bed.	Days Under Fire.	Number of Times Cooled Down.	Coal Carbonized.	Charges missed while clearing of Carbon.	Average weight of Coal Carbonized per day.	Average charge per Retort every four hours.	Average Daily Production of Gas per Retort.	Average Yield per lb. of Coal.	Total production of Gas per Retort.
			Lbs.	Lbs.	Lbs.	Lbs.	Cub. Ft.	Cub. Ft.	Cub. Ft.
2	377	0	2,189,220	18,000	5,807	193.6	5,750		2.167,330
5	427	1	2,547,898	none	5,967	198.9	5,908		2,522,420
11	408	1	2,414,387	31,000	5,918	197.2	5,859		2,390,240
12	374	1	2,274,395	13,000	6,081	202.7	6,020		2,251,650
18	412	0	2,375,492	34,400	5,766	192.2	5,709		2,351,730
19	371	2	2,114,930	40,000	5,700	190.0	5,643		2,093,780
20	342	1	1,983,392	18,000	5,800	193.3	5,742		1,964,560
21	285	1	1,709,914	10,000	6 000	200.	5,940		1,692,815
22	446	1	2,671,475	30,600	6,000	200.	5,940		2,644,760
23	452	1	2,617,297	51,200	5,790	193.	5,732		2,591,125
24	455	1	2,635,910	39,000	5,793	193.1	5,735		2,609,550
25	546	1	3,131,587	59,700	5,735	191.2	5,678		3,100,270
26	520	1	3,125,675	74.600	6,011	200.4	5.951		3,094,420
31	495	1	2,765,393	12,000	5,586	186.2	5,530		2,737,740
34	315	1	1,805,741	13,000	5,732	191.1	5,675		1,787,685
	6,225		36,362,706	444,500					
Mean,	415		2,424,180	29,633 = 1.22 prct	5,841	194.7	28,913 = 5,783	4.95	2,399,940

C

THIRD PERIOD. 1873-1876.

Record of Performance of 19 Beds, of 95 Retorts, 12 by 20 Inches.

These Retorts were worked at very bright orange heat, without Hydraulic Seal, and the actual Pressure in the Retorts maintained at .3 inch.

Number of Bed.	Days Under fire.	Number of Times Cooled Down.	Coal Carbonized.	Charges missed while clearing of Carbon.	Average weight of Coal Carbonized per day.	Average Charge per Retort every four hours.	Average Daily Production of Gas per Retort.	Average Yield per lb. of Coal.	Total Production of Gas per Retort.
			Lbs.	Lbs.	Lbs.	Lbs.	Cub. Ft.	Cub. Ft	Cub. Ft.
2	585	5	3,146,300	26,300	5,378	179.3	5,378		3,146,300
3	705	0	4,208,740	81,000	5,970	190.	5,970		4,208,740
4	717	0	4,198,485	51,000	5,855	195.2	5,855		4,198,485
6	751	0	4,315,350	64,800	5,746	191.5	5,746		4,315,350
7	753	0	4,291,055	58,000	5,700	190.	5,700		4,291,055
8	797	0	4,528,225	53,500	5,681	189.4	5,681		4,528,225
9	811	0	4,502,385	53,900	5,551	185.	5,551		4,502,385
11	521	2	2,865,860	35,500	5 501	183 3	5,501		2,865,860
12	672	1	3,596,130	30,800	5,351	178.4	5,351		3,596,130
13	797	1	4,453,905	82,200	5,588	186.3	5,588		4,453,905
14	835	2	4,516,570	34,000	5 409	180.3	5,409		4,516,570
18	921	0	5,238,330	56,100	5,687	189.6	5,687		5,238,330
19	842	1	4,784,810	57,400	5,682	189.4	5,682		4,784,810
23	927	0	5,280,790	58,000	5,696	189.9	5,696		5,280,790
24	928	0	5,231,115	63,500	5,637	187.9	5,637		5,231,115
30	537	2	2,900,470	73,000	5,401	180.	5,401		2,900,470
34	1,044	0	5,758,450	62,400	5,516	183.8	5,516		5,758,450
35	1,024	0	5,636,070	46,500	5,504	183.4	5,504		5,636,070
36	926	0	4,956,100	41,000	5,352	178.4	5,352		4,956,100
	15093		84,409,140	1,028,900					
Mean.	791		4,442,585	54,155 = 1 22 pr ct.	5,595	186.5	5,595	5.00	4,442,585

RECAPITULATION.

		Days Under Fire.	Coal Carbonized.	Charges Missed on account of Carbon.	Coal Carbonized Daily per Bed.	Charge per Retort every four hours.	Gas made per Retort per Day.	Gas per lb. Coal.	Per cent. of Coke used for Fuel.	Total Gas made per Retort	Candle Power, 5 cubic feet by Referee's Burner.	Candle Feet per lb of Coal.
			Lbs.		Lbs.		Cub. Ft	Cub. Ft		Cub. Ft.		
First Period...	With Dips	712½	4,166,600	4.28 pr. ct	5.852	195	4.960	4.24	46.0	3,533,300	19.	80.56
Second Period.	" "	415	2,424,180	1.22 "	5.841	194.7	5.763	4 95	43.	2,399,940	14.	69.30
Third Period..	Without Dips	794	4,442,585	1.22 "	5.595	186.5	5.595	5.00	36.6	4,442,585	16.5	82.50

The tables show the results to have been—

(1) As to the Production per Pound of Coal.

	Gas made per lb. of Coal.	Charge of Coal per Retort in four hours.	Candle-Feet. Referee's Burners.
A. Low heats with Seal,	4.24	195.	80.56
B. High heats " "	4.95	194.6	69.30
C. " " without seal,	5.00	186.4	82.50

The marked increase in yield of gas from A to B was principally due to the higher heats, but also, in part, to an infiltration of furnace gases drawn into the retorts in the rapidly recurring intervals of vacuum shown by the pressure tests, during three-fourths of the time that the charges remained in the retorts. The low illuminating power of this period confirms this opinion, in connection with the fact, that in period C, when there was a constant, steady pressure in the retorts, the candle power of the gas rose twenty per cent., with a larger yield per pound, From this cause too, this increased production of gas in the third period, due to higher heats and lighter charges, is made to appear less than it really was. The removal of the seal, however, seems to have been followed by no increase in production of gas, not otherwise accounted for; and, I think it may be safely asserted, therefore, that within the limits of pressure commonly found in retorts, no material increase of yield per pound will be obtained, with equal charges and equal heats, from the absence of the hydraulic seal; and further, that if a vacuum be maintained, even intermittently in the retorts, with or without the seal, an increase of volume will occur from infiltration at the expense of the illuminating power.

(2) As to the formation of Carbon.

The actual quantity of carbon removed from the retorts was not weighed, but an accurate account was kept during the three periods, of the loss of duty, in charges missed by each bed, whenever they remained idle for the purpose of scurfing or burning out the deposit. The measure of this loss affords a sufficiently fair index to the weight of carbon formed, for comparative purposes, as between periods A and C, but it is not reliable for period B, for reasons to be given presently.

During the first period this loss of duty was 4.28 per cent. of the total weight of coal carbonized, while for the second and third period, it was, by a curious coincidence, exactly equivalent to 1.22 per cent. As the hydraulic seal was in active operation in the one case, and entirely absent in the other, it seems to be proved by this result that the removal of the seal simply, does not prevent or even lessen the deposit of carbon with equal heats ; but a further consideration of the question will change our interpretation of the figures, and show the important part really played by the seal in this matter. It is well known by every gas maker that the deposit of carbon increases with increase of pressure ; but it is not so well known, having until recently been merely suspected, that the greater and more violent pulsations transmitted by the seal to the gas in the retorts, under increasing pressure, are more potent by far in determining the excess of deposit than the mere pressure itself. This fact, which, as far as I can remember, was first stated *a priori*, in a pamphlet issued several years ago by the Gibson Valve Company, has been quite lately proved by the experiments of Mr. Young, of Clippens, to whom we are indebted for several valuable contributions to the science of gas manufacture. His paper "On the Causes Affecting the Quantity of Carbon deposited in Retorts," read at the last meeting of the North British Gas Managers Association, I strongly recommend to the study of those of our members who may not yet have seen it. On this theory the percentage of carbon formed during our second period of high heats and violently oscillating pressure, must have been even greater than it is shown to have been in the first period of low temperatures. What became of the excess above the 1.22 per cent. accounted for? My explanation is, that it was consumed as fast as deposited by the oxygen drawn through the walls of the retorts during vacuum intervals. I became convinced of this by the fact, that the broken fragments in all the retorts in action at this period were white and clean on their fractured surfaces, without a trace of carbon in their pores, proving that their must have been a current of oxygen passing inwards sufficient, at least, to prevent the lodgment of carbon in the fire-clay, if not to consume the whole quantity deposited within the retort itself. If it be con-

ceded then, that the figures as to carbon in period B are misleading, and the comparison is made between the undisputed results in A and C, we find a clear diminution of 70 per cent. in the deposit obtained by the removal of the seal; the same result having only been reached under the action of the dips, in period B, by maintaining in the retorts an intermittent vacuum detrimental to the quality of the gas produced.

3. As to the Increased Durability of Retorts.—Upon this point the figures need no explanation, and are very instructive. During the first period of low heats, the average life under fire of each retort was 712½ days, producing daily 4,960 cubic feet of gas; a total duty of 3,533,000. The higher heats of the second period raised the daily production to 5,783 cubic feet, but the intermittent vacuum shortened the average life to 415 days, and the total duty to 2,400,000. I shall show presently the financial result of this change of base. Here, then, was a clean loss of more than 40 per cent. in the life time of the retorts, and of 30 per cent. in their total efficiency (to say nothing of the loss in illuminating power), entirely due to the destructive effects of the combustion of carbon in their pores, produced by the attempt to counteract the pressure of the seal by the exhauster alone. When these retorts gave out, like the "deacon's shay," they were gone all over, breaking up into small fragments, between which cohesion was utterly destroyed. Now note the change in the third period. Without the seal, with higher heats, but under a slight steady pressure, the average life was lengthened to 794 days, with a daily production of 5,592 cubic feet and a total duty of 4,442,000. The removal of the seal, and the substitution of a steady pressure increased, therefore, the efficiency of the retorts 25.75 per cent. over that of the first period, and 85 per cent. over that of the second. Nor would it alter the correctness of this view if it should be shown that a longer average life and greater production of gas had been obtained in other works, from retorts of similar dimensions, without removing the seal; unless it were at the same time shown that a corresponding increase of efficiency had failed to follow its removal in the same works. For my object is not to present here a standard of efficiency,

but merely comparative data which can only be opposed by corresponding terms. The shortest life of any bed in Table C was 521 days, the longest 1044. The injurious effect of cooling down a bed after it has been in operation is indicated by the fact that the three shortest-lived beds in this table are those which had been cooled down more than once; whilst the highest duty was obtained from the beds kept constantly under fire. All these retorts when broken up were found to be thoroughly impregnated with carbon.

These technical results may now be supplemented by a statement of the actual pecuniary loss or gain incurred from each change in the method of working the retorts. Assimilating the prices paid during the three periods for coal, retorts, and stokers' labor, to one common average for comparison, I find that the cost of retorts for 1000 cubic feet of gas produced was 2.83 cents in the first period, 4.17 in the second, and 2.25 in the third. The practical gas manager saved his retorts to the extent of 1.34 cents per 1000; but in accomplishing this feat he lost 9.06 cents in coal and 2.40 in wages, a net loss of 10.12 cents per 1000, from the annual production of 250 millions, a total of $25,300 to the credit of the second period. In the third period the gain in coal due to extra yield was exactly balanced by increased cost of labor due to lighter charges; but the advantage of the dip removal is felt in the economy of retorts; the gain being 1.02 cents per 1000, or $4,800 per annum. The whole cost of fitting up 40 ovens of 200 retorts with Edgerton's apparatus was $1,600, which was thus entirely repaid from the benefit derived in the first four months after its application.

I have left out of account here all considerations of the money value of the changes in illuminating power, in the three periods, because the quality of the gas having never been below the legal standard of 14 candles, the variations did not cause any loss or gain to the company. Under higher statutory requirements, however, or when the use of inferior coals cannot be avoided, the removal of the seal would become of material pecuniary importance, in ensuring the full illuminating value of the gas produced.

I think that I have shown that the removal of the hydraulic seal is a real substantial improvement in gas manufacture, effectually preventing the excessive deposit of carbon, improving the quality of the gas, and increasing the efficiency of the retorts. Like most other good things, however, it may be abused and turned to illegitimate uses. Some gas managers consider that all the carbon deposited in their retorts represents a *pro tanto* loss of gas, and consequently look upon its entire absence as a positive gain. By removing the seal and maintaining a vacuum in the retorts, they apparantly prevent its formation; but as a matter of fact, carbon is still deposited all the time. The real effect of this vacuum, as I have before pointed out, is to induce an inflow of oxygen which consumes the carbon, destroys the retorts, and adds a certain percentage of carbonic oxide to the legitimate volume of coal gas. Used in this manner, the removal of the seal will be a delusion and a snare. This heroic treatment of the carbon difficulty is based upon two errors: 1st. That it is an unmixed evil, and 2nd. That it can, profitably, be entirely prevented.

1. It needs no argument to prove that a moderate deposit of carbon, far from being an evil, is of great positive benefit to clay retorts. By filling up the interstices of the loose, granular material of which they are constructed, it cements the particles together, and at the same time bestows the quality of staunchness to the whole vessel, not otherwise possessed nor obtainable by them. When weighed against these vital benefits, the loss of duty of 1.22 per cent. incurred to remove additional encroachment of the carbon is but a trifling inconvenience.

2. The formation of solid carbon in the retorts is a condition essential to the production of permanent gas from the distillation of coal as at present carried on. The quantity deposited may be increased or diminished by varying conditions, but so long as the heat in the retorts is sufficient to make gas at all, some carbon must be deposited. The oils and vapors first given off from every portion of the charge of coal, must be further decomposed by greater heat; and their surplus of carbon not included in the final combinations by which they are converted into permanent gas, must be deposited in the free state.

The weight of carbon deposited, therefore, necessarily increases with the degree of heat to which the vapors are effectively subjected, and their, consequently, more complete decomposition and conversion into gas. It may then be said, with truth, up to a certain point—the more carbon in the retorts the more gas in the holders ; and up to this point the deposit does not detract from the illuminating power. But if the permanent gas thus formed be still further and unnecessarily decomposed by prolonged and repeated contact with the heated walls of the retort, an additional increment of carbon will be deposited, which, in proportion to its weight, will impoverish the gas. Mr. Young thinks that when cannel or shales are used as gas producers, instead of caking coals, this prolonged exposure of the gas may, on the other hand, be beneficial. Now, the effect of the hydraulic seal is to produce just that violent, pulsatory pressure of the gas which increases decomposition by multiplying frictional contacts of its molecules with the heated surfaces of the retort and of the incandescent coke. Hence the excessive deposit of carbon. Nothing less than the entire removal of the seal will remedy the evil, for it is not a question of absolute mean pressure, but of oscillations of pressure, which cannot be destroyed by any adjustment of the exhauster while the seal is preserved. Provided it be steady, the absolute pressure is not, indeed, of much consequence, within ordinary limits, and therefore, the advantages of removing the seal are as completely available to small works where no exhauster is used, as to the largest.

As a summary of the whole question, I shall now submit for discussion the following conclusions to which I have been led, in the course of this investigation.

1st. With equal heats from equal weights of coal, little or no increase of gas is obtained by the removal of the hydraulic seal, unless a vacuum is maintained in the retorts ; in which case the increase is not from the coal, but from the furnace ; and the loss of illuminating power overbalances the gain in volume.

2d. The removal of the seal prevents effectually the excessive deposition of carbon caused by over decomposition of the gas, and thus improves its illuminating power.

3d. With an equal daily production of gas, the durability of clay retorts is nearly doubled by the removal of the seal, provided a slight pressure be steadily maintained within them during the process of distillation.

Mr. Forstall was heartily applauded both during the reading of his paper and at its conclusion.

THE PRESIDENT—Gentlemen : You have heard this interesting paper read by Mr. Forstall. The conclusions will be read again, and after that, before Mr. Forstall leaves the stage, members can ask him any questions they desire answered, and after that the full discussion will be in order.

Mr. Forstall read his conclusions once more, when the following discussion was engaged in by the members of the Association.

MR. MCELROY—That is a question that interests me very much, and one of the questions that brought me here to this Convention. I was formerly running works under seal from half inch to inch and a half, and I made a certain portion of carbon. We built new works and removed the seal entirely by the rotary valve of Mr. Farmer, and I make to-day twice as much carbon as I did under the seal. I would like to have a reason given for that fact, for it certainly is an annoying one.

MR. FORSTALL—Perhaps you have greater heats. With greater heats you will have more carbon?

MR. MCELROY—I couldn't say I have greater heats. I have greater uniformity of heats.

MR. FORSTALL—How long have you been running this way?

MR. MCELROY—Since last November, and I never had such deposits of carbon before. I frequently have to scurf, and have taken out carbon in two months six inches thick.

MR. FORSTALL—And you attribute that to the removal of the seal?

MR. MCELROY—I don't know what to attribute it to—that is what I want to find out. I will state further, that during the time this deposit was being made, the gauge at the mouth-piece was standing at half a tenth.

MR. FORSTALL—Have you ever tried to see whether an increase of that pressure would increase the deposit?

MR. MCELROY—I have tried three-tenths and it increased. I never tried reducing for, I don't want to reduce for the reasons given by you in your paper. I never ran below zero before, and steady at that.

MR. FORSTALL—I can't understand the excess of carbon when you have less pressure on than before.

MR. COGGSHALL—What is your production, per pound, of coal?

MR. MCELROY—It is a little better than with the old works. I am now making 5.25 to 5.30, while I was making 5.10 to 5.15 in the old works.

MR. FORSTALL—I suppose your stand pipes choke up, too?

MR. MCELROY—Very seldom.

MR. FORSTALL—My experience is, that when we are getting 5.25 out of Pittsburg coal, we must look out for the filling up of the stand pipes.

MR. WHITE, of Rochester—I would like to ask Mr. McElroy what kind of coal he uses?

MR. MCELROY—I use what is termed nut.

MR. FORSTALL—That is full of slate, I believe?

MR. MCELROY—There is not over 5 per cent. more slate in the nut than in the lump. I use some lumpcoal, but I only take it because I can't get enough of the nut.

MR. GATES—What is the size of your retorts?

MR. MCELROY—They are 14 by 22; ovals set in sixes. I have six gauges between the retort and the exhauster.

MR. FORSTALL—Your statement only adds to the difficulty of the problem of how to account for the deposition of carbon.

MR. MCELROY—Before going further I want to say that I don't wish to be understood as opposed to the so-called vacuum process.

MR. FORSTALL—We don't take it so. We want light, and if it contradicts every word in this paper it must come out. (Cheers.) This paper was gotten to raise a breeze here, if

possible. (Laughter.) I have often noticed that after the reading of a paper it is suffered to pass without any remarks, but this should not be. No matter how good a paper is, it is always better to hear remarks upon it from the members.

MR. MCELROY—I suppose you are aware of the kind of valve Mr. Farmer has patented?

MR. FORSTALL—I have heard of, but not seen it.

THE PRESIDENT—I, myself, have used retorts without dips, for years, and no carbon ever collects upon the back of the retorts, but upon heating the retorts the carbon drops out.

MR. COGGSHALL—I would like to ask Mr. Neal what the life of his retorts is?

THE PRESIDENT—Nine months.

MR. KING—I want to ask whether there is not some means of removing carbon except by heat? And whether you don't get the carbon although there is no deposit in the retort?

MR. FORSTALL—In case there is not a deposit in the retorts I think some of it goes through in the shape of dry soot. I have seen it often as far as the purifier, but how much will be carried by the gas in that way I don't know. If you decompose your gas so thoroughly as to change the volume into marsh gas you will have to enrich with petroleum or cannel to restore illuminating power.

MR. MCILHENNY—It has been so long since I have spoken to this Association that I am rusty now, but I am very much gratified that a subject which I have been so much interested in, and given so much study to, has been so ably endorsed by a gentleman of Mr. Forstall's reputation. I endorse every word he says so far as carbon is concerned, but we never think of that in our works any more, consequently I have not paid much attention to it for four or five years. But this last summer the subject was brought to my mind again. We were obliged to work for a time on the old plan of the seals, owing to alterations in our works, and, as usual under that system, a good deal of carbon collected, but when we got back again to the new plan of working without seals, the carbon was not observed in any quantity. It will be noticed, that at Cleve-

land, while I did not give the details, I did give the theory. I said then that dispensing with the seal was a very important matter. That, now, is an established fact, so that it needs no argument in its favor, but Mr. Forstall has here given us the details and results of that theory, and my experience is exactly what his is, upon that subject. I can't account for Mr. McElroy's experience. I don't understand it, but I think nearly every one who works retorts without seals has the same experience Mr. Forstall has expressed. Mr. Burtis, I think, has some data on the subject which will prove interesting.

MR. BURTIS—I havn't much to say on this subject. A few years ago, 1872, I think it was, I put in two short hydraulic mains to test the process of working without a seal, and placed them immediately alongside of those with the seal, and found that we carbonized all that we dared put into the retorts. We subsequently added twelve of this same class of main, viz., short mains, each and every one independent of the other. We ran these right along in the same works with the old style—thirty-six mains on one side with a seal, twelve on the other without a seal. We were not able, because of passing the gas all into one receptacle, to determine anything as to the difference in the yield, but I gave instructions to keep a record of all that went in on the side working with a seal and to keep it seperate from the others. Altogether there were fifty-eight working with a seal and thirty-eight without. Instructions were given, as I said, to the foreman, to keep the coal that went into the retorts that were without seals separate from the rest, and this was continued for nine months, and I have the data for that period in my memorandum book at home, both day and date, not only the sum total but charge per bench right along. From that time we put our new works upon that system entirely —each one separate and distinct from its neighbor. We run that station entirely now without seals, but we can add seals at any time we choose by simply turning the water in. At our south station we had no seals, and according to the record there is a difference of .33 feet per pound on the score of production, and 12.98 difference in the coal carbonized, and note the result; we have sold 40 per cent. more tar at the station without

the seals than at the station with the seals. We propose after this to burn our tar, so we don't care how much we get. These are the few items of data that I have been able to give here, and I believe I can add nothing more, except to say that there has been a difference of 1⅜ degrees in the measurement of gas between the two stations.

MR. FORSTALL—What was the average temperature of the gas at the meter?

MR. BURTIS—The average temperature of each one was about the same.

MR. FORSTALL—The average temperature of the gas at the meter, in our works, taking winter and summer together, is 70 deg. Fahr. However, we are on the sea level, where the average barometric pressure is just thirty inches, and a difference of one half inch in the barometer makes a difference of more than 10 deg. temperature, and I think Cincinnati and Chicago have much less than thirty inches, so that one would about cover the other as far as yield is concerned.

Mr. BURTIS—When we started first we had ten benches; one working without a seal. These ten benches being cleaned out the first time—the first having been used six months we took but a small amount of carbon out, a little in the rear end. They were never out of order, while those immediately alongside were cleaned about once in six weeks. It was a loss right along. Now, at the station with seals we have to remove the carbon almost constantly, but where there are no seals we don't pretend to remove the carbon more than once in six months. We started our new station on the 23d day of November, three years ago, and we have the same benches there now doing excellent service.

MR. HENRY CARTWRIGHT—Would you please inform us, Mr. Burtis, what the average difference in yield was between the stations where you had seals and those where you had no seals?

MR. BURTIS—It was a difference of .33 of a foot to the pound.

MR. CARTWRIGHT—What was the yield.

Mr. Burtis—We have had as much as five feet, but I don't pretend that we had that much during a six months' run.

Mr. Benson—I have never tried doing away with the seal altogether, but have used different kinds. The first three years I noticed very heavy pulsations—all the way from one to four inches pressure, but with a different kind of seal the pulsations stopped, and there was also a very large decrease of carbon. The removal of pulsations decrease the amount of carbon nearly one-half—from 4½ or 5 per cent. to 2 per cent.

Mr. Gray—For the further consideration of this subject it would please me much to learn the experience of members with regard to stoppage in the stand-pipes, and also the ascension pipes. In one company with which I am connected this is a very troublesome difficulty, and for that reason is very interesting to me.

The time for adjournment having arrived, further discussion was postponed until the afternoon session, and the Convention adjourned until 3 o'clock, P. M.

AFTERNOON SESSION.

The Convention assembled at 3 P. M., and was called to order by the President, who said: I am sorry the members of the Association are not more prompt. Our time is precious, and we can't afford to waste it. We have five papers here to read, and it will require considerable time to dispose of them all. I wish to inform the members that the officers of the Mercantile Library Association have extended an invitation to the members of the Association to visit their rooms. They have papers there from all parts of the country, which you can see; and you can also look at the books in the Library, by simply stating that you are members of the Gas Association. The rooms of this association are in this building just at the head of the stairs.

I also want to request any member who was not present when the roll was called, to hand his name to the Secretary, so that it may be noted by him.

I have here a letter from Mr. Price, our First Vice-President. I understood, from the telegram he sent, that there was sickness in his family; but it appears from the letter that there was a mistake.

The letter is as follows:

OFFICE OF CLEVELAND GAS LIGHT AND COKE CO.,

CLEVELAND, OHIO, OCT. 16, 1877.

CHAS. NETTLETON, ESQ., *Sec'y, Cincinnati, Ohio.*

MY DEAR SIR: Until this morning I fully expected to attend the meeting of the Gas Light Association. The man upon whom I rely to care for matters in my absence, was taken very ill last night, and I cannot well leave. I have builders at work, and it is difficult to get away on that account; but I should not allow any ordinary difficulty to prevent my visiting Cincinnati at this time. My interest in the American Gas Light Association is undiminished. I have been absent from but one meeting since its organization, and then I was out of the country.

Please make my apology to the Association, and to any inquiring friends, convey my kindest regards.

Believe me, dear sir, very truly yours,

W. H. PRICE.

Now, gentlemen, I have on the table here several papers to be read, and I don't suppose it matters in what order we take them up. When we took our recess, the subject under discussion was the paper of Mr. Forstall; and if any member desires to speak any further on that subject, or wants to ask any questions of Mr. Forstall, or any other member of the Association, with regard to the subject of his paper, they will now have the opportunity.

MR. HENRY CARTWRIGHT—I would like to know the size of Mr. Forstall's stand-pipes.

MR. FORSTALL—Four inches in diameter for the whole time included in this paper. In the new retort house we have six inch pipes, but I don't find any difference between them. I don't think the four inch pipes stopped up any oftener, or any

worse than the six inch pipes do now—in fact, if there is any difference, I think the six inch pipes stopped more frequently than the four inch did. Our old works were built in England, and put up on their plan, and it is not their custom to use as large stand-pipes as we do in this country.

MR. HENRY CARTWRIGHT—The custom here seems to be drifting towards the enlargement of stand-pipes. Four inches used to be the maximum, but we see a great many as high as eight inches.

MR. MCELROY—Our stand-pipes are six inches in the new works, and the dip-pipe eight.

MR. HENRY CARTWRIGHT—Mr. Forstall; please give us some information as to the exhauster. What exhauster do you use?

MR. FORSTALL—We use the MacKenzie exhauster. We occasionally used Beal's exhauster, but there was no apparent difference in the results. With the steam-jet we got a steadier pressure, but the use of different exhausters did not affect the pressure on the hydraulic main.

MR. MCELROY—What is the shape of your retorts?

MR. FORSTALL—They are "D" retorts, sir, with the bottom a little oval—very little—the corners just rounded off. The radius of curvature of the bottom is about three feet, and I suppose they can fairly be called "D" retorts. I found in the old retorts that there was a tendency for carbon to gather in the sharp corner, at the base of the "D," and I cannot say that we have been entirely successful in removing that difficulty for I find that we gather about the same amount of carbon proportionally, and there is the same stoppage in the stand-pipes. The pipes of the upper retorts stop oftener than the others—twice as often. To avoid that as much as possible our front walls are thirteen inches thick. We tried protecting the pipes by a loose ticket of sheet iron; but while we had these shields on the stoppage went further up the pipes than before, but did not diminish in frequency or amount.

MR. LITTLEHALES—I found an increase in the amount of carbon deposited, after the retorts had been once let down and

heated again. It forms a surface upon which the carbon can collect, and it collects more frequently after the retorts have been let down once or twice, than in new retorts?

MR. FORSTALL—Mr. McElroy, in your new house are the stand-pipes any shorter than before?

MR. MCELROY—No, sir; they are about the same length.

MR. FORSTALL—I have found that the length of the ascension-pipe has a great deal to do with its stoppage. The shorter the pipes the oftener they are obstructed.

MR. MCELROY—In our establishment the stand-pipes of the lower retorts stop much oftener than the middle pipes. Our centre retorts are worse than either the upper or lower.

MR. CRENSHAW—I hope Mr. Forstall will describe his method of removing the seal.

MR. FORSTALL—That is no more than a patent process, one out of fifty, which I have no business to puff here more than any other.

MR. BURTIS—As this seems to be a sort of experience meeting, I will state what our experience has been in the use of the different shaped retorts. At the north-side station we have "D" retorts, and at the south side stations we have ovals, and we find no difference whatever, so far as the stoppage of the pipes is concerned between the oval and the "D" retorts. If there is any difference, there might be a little more carbon formed in the oval than in the "D" retorts. The only reason for that, I think, is that when we have a seal on them it is a little deeper than the seal used at the other station.

MR. MCILHENNY—I will ask Mr. Forstall how often it is necessary to clean the carbon out of the retorts?

MR. FORSTALL—On an average, once in three months. We generally do that on Sunday now, because we suspend the manufacture of gas on that day.

MR. MCELROY—How thick is the carbon before you clean?

MR. FORSTALL—It varies; but we generally clean the retorts when their capacity is reduced by the deposit below our minimum charge of 200 lbs. of coal.

Mr. McIlhenny—Before unsealing your dips how often did you clean them out?

Mr. Forstall—Once in six weeks. Under the old system the carbon was deposited more irregularly than it is now, so that, although the total quantity in the retorts might not have been greater than it is now when cleaned out, yet we had to clean oftener to get the lumps out.

Mr. Somerville—I think the coal has something to do with the amount of carbon deposited. I generally have just enough carbon formed to keep my retorts gas-tight; but last summer there was a strike in the coal mines where I get my coal, rendering it necessary for me to change, and immediately there was an excessive formation of carbon in the retorts.

Mr. McMillan—Mr. Forstall accounts for the increase in his yields, during the second period, by saying that the furnace gases were drawn into the retorts, and his statement seems to be very generally accepted; but I don't see how any part of it was due to the air drawn in by the exhauster. I think there is oftener a pressure than a vacuum, and I don't understand why he would lose as much as he would gain—perhaps a little more. I don't know that I have ever thought of it before, but it occurs to me to-day that in breaking up the molecules of hydro-carbon, the quantity of gas is increased by the formation of free hydrogen, and the loss or gain is in that way, and not by the air.

If you have an average pressure of 2.7 inches, and an inch vacuum, I don't know how it would be possible to gain very much by the air drawn in.

Mr. Forstall—I didn't intend to lay much stress upon the gain in the retorts, but I would like to have the gentleman account for the immense deterioration in quality, for we had twenty per cent. less illuminating power, with a greater percentage of gas.

Mr. McMillan—I think the deterioration is attributable to the fact that you drew in oxygen and let out gas about equally, and when you decompose your hydro-carbons, and form free hydrogen, you would deteriorate the illuminating power of the

gas very rapidly. I know air does go in, and I think just as much gas goes out.

Mr. Forstall—There was carbon on the inside which would prevent leakage outwards to a certain extent; but the oxygen might come in through the pores of the retort and be there consumed, forming carbonic oxide, without much loss of coal gas from the reaction of the pulsations. In our case we found a loss of twenty-two per cent. Carbon was formed, and of course, I don't pretend that there was much gain, but it was sufficient to produce carbonic oxide and deteriorate our coal gas.

Mr. McMillan—I can't yet understand how it would be possible for the oxygen to get in where the gas could not get out.

Mr. Forstall—I didn't pretend to say that no gas leaked out. My intention was simply to show the loss of illuminating power due to that mode of working the exhauster. I suppose gas may have gone out too, during the pulsations, but it was not as pure hydrogen, for there was no pure hydrogen in the retort.

Mr. McMillan—We don't know that there was no pure hydrogen there.

Mr. Forstall—Well, that is a matter for future experiment, of course.

The Secretary—I want to ask you, Mr. Forstall, whether, when you ran under pressure, the carbon was harder than when you were running under no pressure?

Mr. Forstall—I could not tell you, really, for my attention was not called to that point at all; but the carbon formed at present in our new retort house appears to be softer than in the old works.

Mr. Helme—It seems to me that it would be impossible for something to pass in while something was passing out all the time. There must be pressure from the outside, if there is a vacuum, that would keep the hydrogen from coming out.

Mr. McMillan—He, at one time, has an inch and a half

vacuum, and, at others, four inch pressure. It is when the pressure is in the retort that the gas leaks out.

MR. GRAY—What about the comparative time for cleaning the retorts under pressure and without pressure, and also the comparative time of cleaning the stand-pipes with and without pressure?

MR. FORSTALL—The first portion of your question has been answered—three months with dips and six months without; the second part of the question I can answer at the next meeting of this Association; but, at present, I am not prepared to to do it. I am keeping a daily record of everything connected with this subject, the results of which I will endeavor to present at the next meeting.

MR. BATTIN—Was there an analysis of the gas made at different times?

MR. FORSTALL—No; not an exhaustive analysis; but the specific gravity was taken and found to be very heavy—more than our average.

MR. BATTIN—I suppose, then, you were perfectly satisfied that the gas was heavier?

MR. FORESTALL—Yes, sir; I had no doubt about it.

THE PRESIDENT here stated that about as much time had been consumed by the discussion of Mr. Forstall's paper as it was possible for the Convention to bestow upon it; and he, therefore, announced the next paper, which was read by Mr. Rankin, on "Carbonizing Coal."

Before commencing to read, Mr. Rankin said:

I want to request the Association to make as little disturbance as possible, because my voice is not very strong, and the less confusion there is the more apt you are to hear. [A voice—put on more pressure.] I will state that we always work under a low pressure.

MR. RANKIN's paper on

CARBONIZING COAL.

It has been said, that "Science and Art differ in this, that Art says—give us Rules; while Science demands reasons." If

so, ours then may be deemed a profession, as we require both rules and reasons. But are we not too often content to work by rule, rather than seek for and demand substantial reasons.

The subject that I have chosen for this paper, viz., carbonizing coal, lies at the very beginning, in fact, out of it spring all others connected with our calling. Much profound thought, and patient investigation, has been bestowed on this subject by those who were far more competent than the writer, therefore, I could not expect to say much that has not already been said; but feeling that there is room for improvement both in the apparatus and process, as usually employed, and with a desire and hope that the discussion of the subject may suggest something practical, and a decided step in advance. I would, with becoming modesty ask your attention for a short time.

In the manufacture of illuminating gas the proper means of carbonizing coal is of the first importance, ignorance on this point has often entailed very serious loss, when by a little intelligence, satisfactory profits would have resulted.

Heat being the important agent in this operation, we can but regret that science has not furnished us with some convenient and ready method of estimating high temperatures; and, until something capable of being reduced to daily practice is discovered, we must be guided by the colors presented by the retorts. This, however, is uncertain, from the fact that when heated retorts are exposed to daylight, the color or temperature appears lower than it really is; or, when they are observed in the dark, the temperature seems higher than it actually is. But constant observation improves the faculty of estimating high temperatures by the shades of color, and continued practice enables the intelligent observer to regulate the working of his furnaces.

The apparatus now used for carbonizing are too familiar to require any description at this time, so we will at once proceed to consider the silent, but powerful, forces that are at work within. There are three of them—heat, cohesion and chemical affinity, especially the first two, as it is by the mutual action of these two antagonistic forces, which have been appropriately termed the attractive and repulsive forces, that the state or condition of all matter is determined; a preponderance of the co-

hesive force producing the solid condition of matter; the equilibrium of the two forces the liquid state; and an excess of the repulsive force the gaseous or vaporous condition.

The proper degree of heat to be employed in carbonizing coal in gas making we will not consider in this connection, but will first notice its effect upon the charge of coal which, we assume, is just being introduced into the retort. "The constituents of the coal are, by the first application of the heat, torn asunder, and converted from the solid into the liquid state, by a further increase of the heat these liquids are converted into vapors and gases, which are, in turn, further torn asunder, by the action of higher temperatures, into simpler compounds; at each step, carbon, in the solid form, being more or less eliminated, and the liquids and gases become simpler in their constitution."

Now, the uniformity of these results depend upon certain unvarying conditions. When coal is distilled at a very low temperature the result is the production of oil vapors; if these vapors be passed through an empty retort, or pipe, of considerable diameter, heated to bright redness, only a very small amount of the vapors are decomposed, and the oil vapors pass almost unchanged. If, on the other hand, the retort or pipe be filled with other pipes, each one of less diameter than the last, thereby dividing the large space into a number of narrow annular passages presenting a large surface, and these oil vapors be passed through this when heated to bright redness, the decomposition is very much increased; in fact, only a very small quantity of these vapors escape decomposition, you will perceive it is not owing to any change in the temperature that produces such widely differing results but simply a change of conditions. "This effect of surface in bringing about decomposition, results from the fact that gases and vapors are comparatively feeble conductors of heat, they allow the heat rays, or pulsations sent into them from the heated walls of the retort, to pass freely through them, without being themselves heated to the extent necessary to bring about decomposition, and, therefore, it is only by direct contact that the necessary amount of heat can be communicated rapidly, in order to bring about the decomposi-

tion of organic substance when in the vapor state." But, while surface is the medium through which the heat is transmitted to the elements of coal to bring about decomposition, due regard must be had to the temperature of that surface. If the heat be too low, decomposition is not effected; if too high, decomposition is carried too far, and the gases become too simple in their constitution. Seeing, then, that the heat limits are comparatively narrow, within which carbonization must be conducted, it is evident we must have some certain means, or arrangements connected with our retorts by which we may secure both the requisite amount of properly heated surface, and insure the contact of the vapors with that surface, if we ever attain the results that experiment seems to indicate as being within easy accomplishment.

This brings us to the consideration of the apparatus now employed, and more especially the mode of using them in this most important department of gas making. The clay retorts, now so universally adopted, I think, are altogether satisfactory, so far as durability is concerned, any lack of efficiency is, in my opinion, almost, if not entirely, owing to a want of subdivision of the processes which actually take place in every coal retort. As we have already seen, coal is always distilled at a low heat, and the condensable vapors are subsequently converted into permanent gases.

We may now consider, whether it is possible with the means employed to maintain nearly a uniform temperature, which is indispensable to uniform results. In practice, we take a retort, say 12"x20"x8'6" long, heated to bright redness, into which we shovel, as rapidly as possible, from 150 to 200 pounds of coal; the consequence is, that, within from twenty to thirty minutes, the temperature of the inner surface of the retort is so much reduced that it is incapable of doing little more than change the solid elements of the coal into the liquid or vaporous state; this process, however, goes on very rapidly, even at the reduced temperature, which fact may be easily determined. With a suitable apparatus, I found by a number of experiments recently made on good Pittsburgh coal, that with the retort heated to the lowest visible red heat, that the volatile matter of the coal'

was expelled at the following average rate. At the end of the first hour after introducing the charge that fifty-eight per cent. of the whole gas producing matter had passed over; at the end of the second hour eighty-five per cent.; and at the end of the third hour, ninety-six per cent., or nearly the whole of the volatile matters, and with the cannel coals the rate was even more rapid. This, then, being the fact, we can very readily forsee what must of necessity be the result. While the heat is so low, the great bulk of the volatile matter is driven over, and, failing to meet with heated surface to decompose them, these vapors are carried forward and gradually condensed into liquids, whose composition is the very elements that constitute good illuminating gas; with different heat, at the proper time, these same vapors could be measurably converted into permanent gases. This low temperature continues till the charge of coal, by contact with the bottom and sides, and by radiation from the top of the retort, has become heated to redness, which usually requires from one to one and a half hours, at which time things are in good condition for efficient work. With a large per cent. of the gas producing material wasted, so far as lighting is concerned, we have now attained the most favorable conditions possible with the retorts as now used for carbonizing coal; and could we maintain just this condition of things, to the end of the charge, it would be well. But, no; as the outer surface of the coal in the retort has become sufficiently heated to melt and form an envelope, or crust, of coke, and this crust having parted with its vapors, is soon raised to a high temperature; through this countless jets of vapor are constantly forced from the enclosed portion of the charge. The temperature of this crust is not only increasing, but the heat is penetrating to a greater depth; the vapors from the interior having to pass through this excess of heat, decomposition is carried to far, carbon is deposited in the form of exceedingly fine particles, imparting to the coke that peculiar white, metallic lustre always observed in coke from hot retorts; and the gas produced from this time to the drawing of the charge becomes gradually poorer in quality. This, however, I think, should not be so. As the coal put into the retort was all alike, it seems

to me, that, with proper manipulation, the product should be the same in quality through the entire process.

For the purpose of testing the correctness of this theory, I recently made fifteen experiments, with suitable apparatus, where the coal was distilled at a low heat, and the resulting vapors passed immediately through a well heated retort or chamber for decomposition, and, with observations every fifteen minutes during the whole four hours the charge remained in, there was a remarkable uniformity in the quality of the gas while the temperature was uniform, but with any considerable increase of the heat of the decomposing retort, there was a larger proportionate yield, but the gas was of a poorer quality; on the other hand, after the heat had been increased, if it was reduced again to the original temperature, there was a corresponding decrease in the yield, but with a perceptible improvement in quality.

Referring again to the defects in our system of working reretorts, I would remark that the process of gas making, being fractional in its character, cannot certainly be commenced and completed at the same time; the circumstances and conditions under which the first part of the process is most satisfactorily accomplished, are not all adequate to its completion. As has already been said, when we crowd two hundred pounds or more of cold coal into an ordinary sized retort, be it ever so hot, the temperature is soon reduced below that at which decomposition is effected. Urge the furnace as you may, yet the heat remains down. Now, by experiment, it appears that this low heat is just about as efficient in liberating and driving over the volatile elements of the coal as a higher heat, while it falls short of decomposition, hence, there must be more or less loss, just in proportion to the deficieney in heat. The difficulty may be overcome, to a very great extent, by dividing the processes, and adopting a different plan of working, so that we may avoid the necessity of trying to perform three delicate operations, in the same vessel, and at the same time.

In regard to the proper heat to be employed in carbonizing coal I think there can be no fixed rule that will apply to the ever-changing circumstances. It has been assumed, from the

beginning of this paper, that the coal should only be subjected to a comparatively low heat in gas-making; this I am aware is contrary to the opinion now entertained, and directly to the opposite of universal practice; nevertheless, after many experiments, and careful observation, I feel warranted in the conclusion that several most serious difficulties may be greatly alleviated, if not entirely overcome, by a change of practice in this respect, some of which I will enumerate—the excessive deposit of carbon in the retorts; reducing the quantity of tar; removing the naphthaline nuisance; and by making it possible to control the heat within certain limits. And while I would discourage the application of high heats directly to the coal, I would, on the other hand, say that a reasonably high heat is absolutely necessary to the treatment of the vapors arising from distillation at a low heat. In order to ascertain, if possible, the best heat, I have made a number of experiments with the following results, taking the average of several successive trials (with good Pittsburgh coal), the heat being what we will call bright redness, or, as I suppose, from 1800° to 2000°F. The yield was at the rate of 10,600 cubic feet, of 20.5 candle gas to the ton (2240 lbs.) of coal. Then, with the same coal and same apparatus, but with the heat of the retort raised to a vivid red, bordering on whiteness, supposed to be about 2600°, yield was at the rate 13,600 cubic feet, of 10.27 candle gas, to the ton of coal, which would seem to indicate that too high heats are not desirable; it is a fact worthy of notice that, while the yield in the above experiment was increaeed twenty-eight per cent., the quality of the gas was brought down just one-half.

This effect of high heats on the rich gases from coal is owing to the fact that, when the two gases or vapors unite chemically, a contraction of volume ensues; take, for example, olefiant gas (C_2H_4) composed, as it is, of two volumes of carbon and four volumes of hydrogen—these six volumes, when chemical union takes place, contract into two volumes, or just one-third; or take napthaline ($C_{10}H_8$) whose proportions are ten volumes of carbon and eight of hydrogen, these eighteen volumes, when chemically united, occupy the space of only two volumes, or one-ninth of its uncombined volume.

Now, if these gases rich in carbon are subjected to excessive heats, dis-association takes place, the carbon is deposited in the solid form, and the hydrogen, being set free, expands into its original volume.

In conclusion I will take occasion to say that I am not disposed to undervalue the results that are being had every day in all well managed gas works, for I honestly believe that the results now obtained are about as good as can be had with the apparatus now used, and the mode of carbonizing ; and, at the same time, I am just as honest in the belief that, with modified apparatus, and with better treatment of the coal, that the average yield may be very considerably increased in volume, and yet quite as good in quality.

I thank you, gentlemen, for your courtesy and attention while I have presented these common-place and well known facts ; and, as I accepted the invitation to read a paper, I have felt bound to fulfill my promise, although I could not hope to say much to you that was new on this subject.

At the close of the reading of Mr. Rankin's paper the President said :

Gentlemen : The paper and the writer are before you, and you can ask him any question that you like.

MR. COGGSHALL—In ascertaining the candle-power of the 20½ candle gas from 4.73 to the pound, I would like to ask whether it was by bar photometer or jet ?

MR. RANKIN—Bunsen's photometer, with the London burner, a part of the time ; and a part of the time I used Sugg's standard burner. I used Sugg's bat's wing and fishtail, and found the ordinary fishtail burner gave a better result than the London burner did.

MR. LITTLEHALES—I would like to ask if the results were obtained by any method of superheating the vapors from the ordinary retort ?

MR. RANKIN—The coal in these experiments was subjected to a low temperature, not with a view of converting the solid elements into gas at once ; but while the elements were still

heated they were passed into a second retort or vessel, when they were decomposed.

MR. LITTLEHALES—That is what I supposed. I have been experimenting a little myself in this same direction. I set an iron retort on the top of the retort arches, and heated it with the waste heat from two benches of fives, and passed the gas from the hydraulic main through this retort. During these experiments I scarcely found a trace of tar, nearly the whole of the hydrocarbons having been decomposed, and converted into dry carbon in the form of soot or lamp-black, and probably hydrogen gas. I had to abandon it temporarily, because the stoppages were very frequent; but I think that was mainly because the supplementary retort was too hot. I have often noticed, and doubtless you all have observed the same thing, that when a retort is just charged, a great many heavy vapors come off, which are so dense that they will scarcely burn at the mouth of the retort; and there can be no doubt at all but a large proportion of the vapors distilled from the coal, near the mouthpiece end of the retort, are pushed forward to the ascension pipe by the gas which is being more rapidly generated at the back end and middle of the retort, and are never raised to a sufficiently high temperature to be made into gas at all, There is some difficulty in working the system I have mentioned. In the first place the heat of the supplementary retort is a very important matter, just a dull red, would I think, be best; and then, again, the size of the supplementary retort, or the area of the superheating surface, in proportion to quantity of gas made, and it is also absolutely necessary to have the time of charging the retorts so arranged that they shall follow each other in regular succession, and so as not to have to many charged at once, or else there is a tendency to overcarbonize the coal at one time, and the gas itself is decomposed, and at another time it is not sufficiently carbonized. I feel sure, from experiments which have been and are being made in various places in this direction that the time is not far distant when some such method as this will enable us to obtain such a yield of gas from the coal that very few of us at present anticipate.

MR. BATTIN—I would like to ask Mr. Rankin if there was

an increase in the quantity of coke left after this method?

MR. RANKIN—I would say, in regard to the coke, that it presents a very different appearance from the ordinary coke. Its heating qualities are about the same, but it presents a very different appearance. It is of a very dark color compared with the other coke. It has none of the bright, metallic appearance of that made in hot retorts, nor do I think it possible to make that kind of coke without the deposition of carbon.

MR. COGGSHALL—You say, that when you were producing six feet to the pound, you distilled the coal at a low temperature, then ran into a retort of a higher temperature. I can't account for the decreased illuminating power. I tried an experiment with four retorts, running the gas into the top retort, and produced 19½ candle gas. I didn't get the quantity of gas you did, but that was because my heat was too great.

MR. RANKIN—A series of experiments was made under a back pressure of one half an inch as near as I could work it, and I may say, as a result, I am in favor of back pressure.

MR. GRAY—What was the length of each of the charges.

MR. RANKIN—Four hours. I may say here that I don't apprehend any trouble from hard tar or pitch, for my impression to-day is, that with the low temperature you will not produce real tar—it will not be tar. Therefore, it is not worth our while to anticipate trouble where it don't exist. You can't produce tar under a certain temperature.

MR. WOOD, of Syracuse—Is not your process the same that was in operation some time ago at Yonkers, New York.

MR. RANKIN—I do not know, sir.

MR. WOOD—If so, I will say that it has been abandoned there.

MR. RANKIN—The experiments I allude to were in view of utilizing waste heat. From experiments made during the past few months, I am led to conclude that there is enough waste heat in every retort house to do all the distilling, and with a slight modification of the apparatus now in use, I think there can be a considerable yield of equally good gas. But I have not satisfied myself on all points. I expected to try experi-

ments on a very extended scale, but in a recent enlargement of our works it became necessary to throw a portion of our apparatus out of use, so that I failed to carry the matter as far as I otherwise should have done. I simply give my results as suggestions, and hope that some one else will be interested in the matter, now that there is the ability here to carry the investigation so much further.

MR. HELME—It seems to me that with the low temperature for four hours, you wouldn't get all the valuable vapors out of the coal.

MR. RANKIN—But I am satisfied I did, sir, and I think you would find it well worth your while to try a few experiments in regard to low heats upon the gas producing elements in coal. A gentlemen remarked to me once that he was satisfied that with low temperatures he could take all the gas out of the coal, and if he had red heat for four hours I will admit that he could. You will be surprised at the rapidity with which these volatile materials pass out of the retorts. But what I gave you in regard to that in the paper is absolutely true—not the result of one observation, nor ten, but a series of experiments extending through three or four months.

MR. HELME—What is the size of your retorts?

MR. RANKIN—I use a five inch wrought iron retort, so that I can raise or lower the temperature with impunity.

MR. MCMILLAN—Which was the best coke—that made from low heats or from high heats?

MR. RANKIN—I havn't compared them very carefully. All the coke made from high heat is quenched with water, and is, of course, very much heavier. In my experiments I used no water at all, so that I had every particle of coke. I weighed it, both before and after, and I have all the data in my memorandum book at home.

THE PRESIDENT—You weighed it in an incandescent state?

MR. RANKIN—Yes, sir.

MR. HELME—Would you use two or three retorts at low temperature, and two or three at high, or how?

MR. RANKIN—My opinion in regard to the matter would be

to use the ordinary retorts in the benches we now have, and in the place of D retorts would have partition walls, say two inches thick, and would work through retorts—take the gas in at one end and out at the other—would charge at both ends with the coal. I am satisfied, from experiments that I made, that it is impossible to decompose vapor given off from many retorts, until the mass of coal has attained that degree of heat necessary for decomposition.

MR. HELME—It does seem to me that, with retorts of the ordinary size, and running a full charge, at a low temperature, it would be impossible to get the gas out of the coal in four hours.

MR. RANKIN—Notwithstanding that it is true that it can be done.

THE PRESIDENT—If there are no more remarks to be made on the subject of this paper we will pass on, and listen to a paper prepared by Mr. Thomas Curley, which, at his request, will be read by the Secretary.

ON NAPHTHALINE.

By Thomas Curley, of Wilmington, Del.

MR. PRESIDENT AND GENTLEMEN: At the request of our worthy Secretary, I have prepared a few remarks on the system which I employ for the purpose of preventing, or at least, lessening the deposition of naphthaline crystals about our works, particularly in the inlet pipes to the holders, which had formerly given us so much trouble.

In doing so I have not considered it necessary to go into the history of this substance and its characteristic properties, except to revert slightly to its formation or production. In the destructive distillation of coal in gas works, naphthaline vapors are always given off, until the greater portion of the bituminous matter of the coal is expelled; whether the heats be what we term high heats or low heats, those vapors are always given off, and will crystallize or not, just in proportion to the temperature of the

retorts, and the quantity of light vapors in the gas. If the temperature be moderate or low, a considerable quantity of light hydrocarbon vapors will escape decomposition, and their presence in the gas mixture will prevent the naphthaline vapors from crystallizing; if, on the contrary, our heats are extremely high, the greater portion of those light vapors is decomposed, forming new and stable compounds, which have no neutralizing effect on the naphthaline vapors; another portion is absorbed by the tar, the remaining portion, which is held in sussuspense by the gas, is too small in volume to counteract the tendency of the naphthaline vapors to crystallize, hence the trouble to which we are so often subject. Under these circumstances what is best to be done? We cannot return to low heats, it is unprofitable; we cannot afford to rely on the tar for the extraction of those vapors out of the gas, we risk too much in doing so, because the tar will make very little distinction between the naphthaline and light vapors; it will absorb both. The free use of coal oil is undoubtedly an effective remedy, and will prevent the formation of crystals, while adding to the illuminating power of the gas; and the only question to be considered, is its safety and cost. The process used in our works is in one respect the result of necessity. I found the inlet pipes to the holders stopped so frequently that I was compelled to use steam every few days, that by dissolving it we might pump it out. The trouble and inconvenience became so great that I resolved to expel from the tar the benzol and naphtha series of hydrocarbons, and mix them with the gas, knowing them to be great solvents of naphthaline. With this view I constructed a small still and separator; in the still I placed a small coil of steam pipe, and caused the tar I made to pass through this still. I examined the inlet pipe immediately before heating the tar, and I found three-quarter inch of crystal on the inside. I then heated the tar to about 170° and allowed its vapor to pass on and mix with the gas. After the expiration of twenty-four hours, I again examined the inlet pipe, and found it as clean as when new, showing that the expelled vapors had dissolved the crystals which had been formed. This was in January, 1876. Up to this time we used from 5 to 8 per cent. of Cannelton Cannel, but since then we discontinued its use altogether.

In the process the tar (after the expulsion of the light vapors) and liquids, flow on to their respective receptacles. It is automatically arranged, and requires no attention, comparatively speaking. We get the light vapors out of the tar without any expense, and utilize them first as solvents, and secondly as illuminants. It is well known that even small quantities of light, hydro-carbon vapors add materially to the illuminating power of the gas, and hence, the greater the quantity the tar can yield, the less the danger of napthaline crystals, and more illuminants will be added to the gas. But, as I have already intimated, I may carry the process of carbonization to such an extent as to leave very little of that light vapor in the tar. In such a case there will, of course, be no substance left in the gas, of a solvent nature, to counteract the crystallization of the naphthaline vapors. Under such circumstances they will undoubtedly crystallize.

But such policy I consider as being very doubtful, indeed. I would not, on any account, decompose all of the light, hydro-carbon vapors in the process of distillation; for, by doing so, I would first rob the gas of one of its principal elements of light, and leave the napththaline vapors free to crystallize according to their nature; second, by the breaking up of these vapors they become resolved into numerous light carbides, the principal portion of which being marsh gas and hydrogen, and destitute of luminosity, only necessitates the subsequent enriching of the gas by cannel or oil.

Gentlemen, I hold that by proper manipulation our principal coals (*i. e.* coal from Westmoreland region), need no enriching material to maintain a yearly average of 10,800 feet to the gross ton, and a power of 17 candles. This has been my experience, and, for aught I know, others may have far exceeded it. What I state with regard to our results, be they favorable or not, can be substantiated by the president and directors of our company. The comparative result, thus far obtained in our works (taking the years 1875 and 1876), shows a gain of 2 per cent. in yield, and of candle power 48–100; the average candle power for 1875 was 16.60, and for 1877 was 17.08. Our freedom from naphthaline crystals is

one of the most gratifying results obtained, and was unknown to us before.

In 1875 we used cannel; in 1876 we used none, showing conclusively that it is to our advantage to continue the process. I don't profess to have discovered the fact that benzol and naphtha vapors will dissolve naphthaline, or add to the illuminating power of the gas; but only the simple and inexpensive method of getting and utilizing those vapors.

Whatever important and startling discovery there may be in the future, in the interests of gas manufacturing, one thing is imperative at the present time, and that is, to look after, collect, and utilize everything committed to our charge, whether it be the leakage of mains, services, meters, etc.; or the constructing and setting of retorts, their temperature, and that of our condensers or purifiers.

As the mass of matter is made up of atoms, so we will find that our success depends very much upon the aggregation of small things.

At the conclusion of Mr. Curley's paper, the President said:

Gentlemen: I have another paper on the same subject, which has been prepared by Captain Dresser, and as the Captain is a very modest man, if he desires it, I will read the paper for him.

CAPT. DRESSER said: Gentlemen—I am afraid you will all get tired of this subject before you get through with it. However, I haven't prepared much, and I want to state, to begin with, that it isn't any of it mine. [Laughter.]

ON NAPHTHALINE.

$C_{10}H_8$.

By Capt. G. Warren Dresser.

MR. PRESIDENT AND GENTLEMEN OF THE AMERICAN GAS LIGHT ASSOCIATION: In presenting for your consideration, the results of some study of this subject, it is my aim to collect and

lay before you known facts rather than to advance any theories new in themselves, or novel in their application to solving the many difficulties which this same $C_{10}H_8$ entails upon the gas manager.

There may be some of those present who are entirely unfamiliar with the appearance of this beautiful, yet troublesome article. Happy is the gas engineer who is equally unfamiliar with the results following the deposits in his pipes and services.

It is composed, as the chemists tell us, of carbon and hydrogen, and its chemical formula is $C_{10}H_8$. In studying the many compounds of C and H, which result from the various processes of gas manufacture and its residuals, the part that *temperature* plays in determining the composition of the hydro-carbons resulting, is a most important one. This is generally understood, and it is almost an axiom in gas making, that "high heats produce naphthaline." At any rate, whether this be true or not, it is generally accepted as one explanation of its cause. Now, if this was the only cause for its formation, it would be easy to prevent it by reducing the temperature of distillation, but here again the manager would be confronted with the question from his directors, "Why do you not get more gas from a ton of coal," and he often would have to determine which was the greater nuisance, the occasional appearance of the $C_{10}H_8$, or the continued inquisitiveness of the "economical director," ever anxious to assist the engineer in bringing up his results. We know, however, that in many a well ordered works the annoyance is not confined to either one of these cases. Let us now take up the subject:

First—By trying to understand the true chemical character of the body.

Secondly—By studying what has been done by others in determining the cause and manner of formation of the substance.

Thirdly—By stating the results of various methods of preventing and removing the many annoyances resulting from its formation or deposition, both about the works and in the pipes and services in the street.

First, then, as to the chemical character of naphthaline.

In the edition of "Townes' Chemistry," issued in 1847, we find the following under the head of "Naphthaline." When in the distillation of *coal tar* the *last* portion of the *volatile oily product* is collected apart and left to stand, a quantity of solid crystaline matter separates, which is principally composed of the substance in question. An additional quantity may be obtained by pushing the distillation until the contents of the vessel begin to char; the naphthaline then condenses, but is dark colored and impure. By simple sublimation, once or twice repeated, it is obtained perfectly white. In this state naphthaline forms large, colorless, transparent, brilliant, crystaline plates, which exhale a faint and peculiar odor, which has been compared to that of the narcissus. Naphthaline melts at 176°, to a clear, colorless liquid, which crystalizes on cooling; it boils at 413° and evolves a vapor whose density is 4.528. When strongly heated in the air it inflames, and burns with a red and very smoky light. It is *insoluble* in cold water, but soluble to a slight degree at a boiling temperature. Alcohol and Ether easily dissolve it. A hot saturated alcoholic solution deposits fine irredescent crystals on cooling.

"The history of the formation of naphthaline is rather interesting. It is perhaps the most stable of all the complex compounds of carbon and hydrogen. In a vessel void of free oxygen it may be heated to any extent without decomposition, and indeed, where other carburets of hydrogen are exposed to a very heat, as by passing in vapor through a red hot porcelain tube, *a certain quantity of naphthaline is almost invariably produced.* Hence its presence in coal and other tar is *mainly dependent* upon the *temperature* at which the *destructive distillation of the organic substance has been conducted.* Lamp-black very high frequently contains naphthaline thus accidentally produced." (Townes' Chemistry, 1847 edition, page 436.)

Thus we see that thirty years ago points were hinted at, which to-day are taken up again, or are rediscovered and presented for the consideration of the gas manager. It is true that but comparatively little was known of many of the coal tar products at that day, as the same writer says in another paragraph,

speaking of the compounds of the same : "The composition of these substances is as yet very uncertain."

But, in the thirty years that have elapsed since the issue quoted from above, the chemist has not been idle. The marvelous strides made in the study of hydro-carbons is well known to most of you. In fact, so great has been the mass of information acquired in this particular branch of the subject, that to the ordinary gas manager the array of facts is almost bewildering. One of the latest and best works on this subject is "Roscoe's Lessons in Elementary Chemistry," printed in London, 1877. It has the advantage of being a small book, but it is very full. In speaking of the *carbon compounds* it says, "The first striking peculiarity which the carbon compounds exhibit is their extraordinary number, those already known far exceeding all the compounds of the other elements taken together, and new ones being daily brought to light. The second peculiarity is, that they are almost all of them formed by the union of carbon in different proportions with one or more of three other elements, viz., H., O., N. The cause of the multiplicity is to be sought in the fundamental and distinctive property of carbon itself, viz., the power of *uniting with itself* to form complicated compounds." To those desirious of familiarizing themselves with what has been found out up to date, regarding the hydrocarbons, we would suggest a careful study of this work.

In the tenth edition of "Towne's Chemistry," published in 1875, we find the following, in addition to what was quoted above from the edition of 1847 :

"Naphthaline results also from the decomposition of toulene (C_7H_7), qylene ($C_6H_4(CH_3)_2$, cumene $C_6H_3(CH_3)_3$, by a red-heat (each of these are benzine compounds containing respectively 7, 8 and 9 atoms of carbon). It is also obtained by passing the vapor of benzine (C_6Hc) or anthracene ($C_{14}H_{10}$) through a red-hot tube. In gas making it is obtained as a by-product *from reactions similar to the above.*"

Further on we shall refer to examinations showing this to be the case.

Roscoe, page 425, edition 1877, thus gives the chemical character of naphthaline :

"This hydro-carbon occurs in large quantity in the heavy oils, and is formed when the vapors of benzine and many other substances, even alcohol and acetic acid, are led through a red-hot tube. Naphthaline crystallizes in large, white, pearly plates ; it melts at 80°C. (176 F.) and boils at 217° C. (423 F.) but *sublimes* at a *lower* temperature. The carbon atoms in naphthaline are connected together in a similar way to those in benzine. The eight atoms of hydrogen in $C_{10}H_8$ can be successively replaced by chlorine, but naphthaline can combine directly with chlorine, and a series of further substitution products can be obtained both from the dichloride ($C_{10}H_8Cl_2$) and the tetrachloride $C_{10}H_8Cl_4$, so that these chlorinated derivatives of naphthaline are very numerous. By the action of nitric acid upon naphthaline four nitro substitution products are formed."

From this may be gathered an idea of the chemical character of our troublesome guest. While this body is insoluble in cold water, and but slightly so in boiling water, it is very soluble in steam. In fact steam is one of the most powerful solvents of it, but the naphthaline will recrystallize as soon as the temperature is reduced to the proper point. As an *example* of this, the deodorizing apparatus of the Manhattan Gas Light Company of New York, for deodorizing the foul lime, has connected with it a sewer of about 1,000 feet in length, into which the air is drawn through the foul lime in the boxes, after the covers are raised, from which this air is forced by a fan-wheel, passed through other boxes containing ventilated foul lime.

In a communicated article to the *American Gas Light Journal*, vol. 24, page 113, is given an account of this, in which the following occurs that is germain to our present subject. "The sewer pipe leading to the deodorizing house, is coated, on the inside, to the extent of five or six inches in depth, after a year's use, with crystallized naphthaline, which is *removed* by introducing a jet of steam, and blowing it through by the exhauster. Upon one occasion we filled the *washer* above referred to (this washer was for washing the air after it was drawn through the boxes) with slats for a better distribution of the water, but after deodorizing four or five boxes we were obliged to remove them,

because we found that the washer was *completely choked* with crystallized naphthaline. This would seem to indicate that a large quantity of naphthaline is arrested by the lime in the purifying boxes, for there is no other source whence it could be derived during this operation."

I have seen the application of steam referred to, and the result was a most beautiful "snow storm" of pure, finely divided crystals of naphthaline in the deodorizing house. It was deposited to a depth of several inches upon everything in the room. The flakes were not seen until the solution of $C_{10}H_8$ in the aqueous vapor had reached about five or six feet above the floor, when the temperature was sufficiently reduced for recrystallization to take place, and the "snow" resulted.

Here it would appear that there was no absence of naphthaline, and yet the company in question do not run very high heats, and have almost no trouble in the street lamps, and none in their services.

A single instance occurred within a year, where a large establishment, a brewery, complained of "no gas." There being no complaints of naphthaline anywhere at the time, in all their district, this never occurred to them as a possible cause of the obstruction. The meter was examined and the service pipes blown out, but no benefit followed. The service was uncovered and found all right. Following the main house-pipe into the building, it was found that it passed for some distance under a large room used for storage of ice. Upon locating the stoppage it was found to coincide with the portion of the pipe beneath the ice. Upon the pipe being disconnected it was found *filled* with naphthaline, completely preventing the passage of the gas into the building.

Here, certainly, condensation must have been the cause. Why high heats produce $C_{10}H_8$ in gas making is evident from the nature of it; it is obtained by the highest heat in distilling coal tar. It is the last portion of the oily, volatile product that, left apart to stand (and cool), gives a quantity of solid, crystallized $C_{10}H_8$, and an *additional* amount may be obtained by pushing the distillation still more. It is formed directly in the laboratory by passing various of the hydro-carbons through red-hot

tubes. I will now give you a translation of a paper to which was recently awarded the first prize by the "Société Technique du Gaz d'eclairage en France." Its author, Mr. Lucien Bremond, is the manager of the Versailles Gas Works, and has certainly brought to this subject much careful thought and practical investigation.

PAPER OF MR. LUCIEN BREMOND TO THE "SOCIETIE TECHNIQUE DU GAZ D' ECLAIRAGE.

Naphthaline $C_{10}H_8$ is a body whose study has caused very numerous and varied researches, both as to the cause of its production and the means to avoid it.

It is, in fact, the greatest nuisance about a gas works, since it produces an obstruction of the pipes about the works, or in the street mains and services, meters, etc.

Without entering the details of the investigation upon this subject in France, in England, and in Germany, I may say that the conclusion arrived at in them all is this: "The appearance of naphthaline, and especially its disastrous effects, date from the time when the distillation of pit coal at high temperatures was commenced. The only remedy found for this evil is to secure a perfect condensation, and to leave the gas as long as possible in contact with the tar in the pipes of fabrication.

This double conclusion, outside of the sanction in practice, is verified theoretically. In the distillation of coal at high temperatures, on the one hand, we effect the more or less partial distillation of the tar (for every one knows that in the manufacture of naphthaline in the arts, it is obtained by distillation of tar). On the other hand, the temperature of the retort permits the development of igneous reactions, so well and deeply studied by Mr. Berthelot, and which I propose to examine in passing, so far as they relate to the production of naphthaline. First of all, it is necessary to enumerate the gases of the hydrocarbon series, which analysis shows to be contained in illuminating gas. They are :

Marsh gas $C\ H_4$	Propylene C_3H_6
Acetylene C_2H_2	Butylene C_4H_8
Ethylene C_2H_4	

Those igneous reactions, of which one of the most interesting (due to Mr. Sannsure) is the production of $C_{10}H_8$, in the decomposition of the vapor of ether, or of alcohol, by a red heat, reduce themselves to four principal combinations.

1st. Condensation polymerique.

2d. Combination of carburets between themselves, and with hydrogen.

3d. Inverse decomposition..

4th. Reciprocal decomposition.

By polymerique condensation we find that acetylene can produce benzine or styrolene.

$3C_2H_2 = C_6H_6$

Acetylene Benzine

$4C_2H_2 = C_8H_8$

Acetylene. Styrolene.

The benzine thus produced, heated with the acetylene, will give by direct combination stryolene:

$C_6H_6 \times C_2H_2 = C_8H_8$

Benzine. Acetylene. Styrolene.

By decomposition of the hydro-carbons into hydro-carbons, with small proportions of hydrogen, and into hydrogen, or by inverse combination.

Ethyline gives hydrogen and acetylene:

$C_2H_4 = H_2 \times C_2H_2$

Lastly, by reciprocal displacement of the hydro-carbon groups, we reproduce benzine and styrolene:

$C_{12}H_{10} \times C_2H_4 = C_8H_8 \times C_6H_6$

Diphenyle Ethylene Styrolene Benzine

Thus with ethylene, olefiant gas, we produce acetylene, with acetylene we produce benzine and styrolene, which gives us all the elements for producing naphthaline. In fact,

1st. Styrolene and Acetylene give Naphthaline.

$C_8H_8 \times C_2H_2 = C_{10}H_8 \times H_2$

2d. Styrolene and Acetylene give Naphthaline.

$C_8H_8 \times C_2H_4 = C_{10}H_8 \times 2H_2$

The two reactions serve to explain the formation of naphthaline during distillation at high temperatures.

More of them may be found in the memoir of Mr. Berthelot, published in the Bulletin of the Chemical Society, but they are more complex, and their study would exceed the limits of our paper. Here, then, you have the two causes of the production of $C_{10}H_8$ by the distillation of coal at high temperatures. First, more or less, perfect distillation of the tars, and

2d. Igneous reactions. We shall see, further on, that a third cause for it exists.

As to the remedies proposed against the nuisance of $C_{10}H_8$, they are all based upon its solubility in tar, such as the prolongation of the contact of the gas with the tar (worm ?), or upon its solubility in the oils of naphtha, petroleum, etc., distilled with the coal, and easily condensable, or spread out over the purifying material. This was the state of the question when I undertook these researches, under the direction of the learned engineer of the Parisian Company, Mr. Arson, and there it is to-day.

Those examinations which I review to-day, bear upon two points, viz.:

1st. What is the influence of aqueous vapor injected into the gas by the exhauster under a pressure of five atmospheres?

2d. Is a change in the electric state of the gas one of the causes of the production of naphthaline?

The series of experiments to which I invite your attention, allow me to reply that the injection of aqueous vapor into the gas *would* give birth to some naphthaline.

As to the influence of a change in the electric state of the gas, I have been able to find nothing which permits me to suppose that this is a cause of the production of naphthaline. Neither by passing electricity into the gas by a very ingenious machine, constructed under the direction of Mr. Arson, nor by causing an electric spark to be disengaged by means of a very strong Rumkorff coil, in a tube filled with gas during an entire day. I was unable to produce, by either of these two means, a single atom of naphthaline. The question remained just as

it was, viz: Does naphthaline pre-exist or not, with gas? From new observations and new experiments necessitated by a considerable production of $C_{10}H_8$ in the works which I manage, I have been led, I think, if not to a categorical answer to this question, at least to the discovery of another cause of the production of naphthaline, and consequently to a means of preventing this production.

But, what these observations and experiments do enable me to say is this, that if $C_{10}H_8$ pre-exists in the gas *after the apparatus for condensation and purification* (which I do not believe), its deposit is due to a physical phenomenon. While, if it does not pre-exist after the purification of the gas, its deposit is due to a chemical phenomenon. Now, these observations and experiments bear upon a single point, that is, that naphthaline *is produced always* when there is a condensation of the aqueous vapor contained in the gas—that this deposit is preceded by the phenomenon of the condensation of the water, and that gas, absolutely dry, deprived of its aqueous vapor as much as it is possible, for the absolute desiccation of the gas is very difficult to accomplish; that gas, I say, absolutely deprived of the vapor of water, does not deposit naphthaline in the ordinary conditions of temperature and pressure.

If, then, naphthaline does pre-exist in the gas after its purification; if its crystalline deposit is due to a physical phenomenon, if the crystallization is preceded by the condensation of the vapor of water contained in the gas, it obeys a law which I might formulate thus:

"In a mixture of several vapors, when one of the vapors attains its point of condensation, it displaces the point of condensation of the vapors with which it is mingled."

This law, has, as yet been neither established nor verified. I have submitted it to the consideration of experienced physicists, and I may say that it is now the subject of study by a learned professor of physics, a friend of mine, whom I cannot otherwise designate than to say he is the director of the laboratory of Physics of the High Studies of the College of France.

I abandon this hypothesis and return to that of the *non* pre-existence of naphthaline in the gas, which is the one that I maintain.

Naphthaline does not pre-exist in the gas, for in all the apparatus which the gas traverses, it is submitted to a temperature much lower than the condensing point of $C_{10}H_8$, which falls to 79° Cent. (176 Fahr.), and boils about 216°—220° Cent. (419—428 Fahr.), under a pressure of naphthaline (especially that which the gas could hold in solution up to its point of saturation) would then be deposited at a definite point, and the gas, after having abandoned the greater part of what it contained, in consequence of the realization in all gas works of the remedy previously cited, which consists in leaving the gas as long as possible in contact with the tar; this gas, I say, were it still saturated with the vapor of naphthaline at the entrance of the purifiers, in spite of an energetic refrigeration in winter, for example, would no longer deposit considerable masses at determinate points of its course, as I will show. Crystallized naphthaline makes its first appearance in gas works that distill at high temperatures, under the covers of the first purifying boxes, that is to say, before its second passage into the purifying boxes, if it enters into the last from above, or in the pipes which precede them, if it enters from below. Up to that point little or no naphthaline is sublimed, because in each works, even those where the condensation is most perfect, the gas always arrives at the first purifiers, holding in suspension some tar, which is totally arrested by the first filter. At the outlet of the purifiers naphthaline is deposited, when the pipes are at a temperature sufficient to allow the vapor of water contained in the gas (either that coming from washing the gas, which the temperature of the reaction in the purifiers has not allowed to condense, or that due, as we know, to this same reaction) to condense either in whole or in part. Then the pipe to the station meter is less and less obstructed, the gas abandoning also less and less of its aqueous vapor. At the station meter the gas is saturated anew with aqueous vapor, and while the inlet has its section almost free, its outlet is closed, or comes to have a section much more restricted by the naphthaline that collects there, the nec-

cessary conditions being fulfilled for the condensation of aqueous vapor. The same thing happens at the inlet and outlet of the holders, and the outlet governors, but to an extent less perceptible, inasmuch as the entire mass of the gas does not come in immediate contact with the water. These observations are the result of notes made in the works which I direct, when, as I have said, the production of naphthaline is considerable; this is due, perhaps, to a cause which I have not made known here, although it may be a strong argument in favor of the theory of which I sustain.

I will cite one case. On the first of December a new station meter, with new outlet and inlet pipes, was placed in service. Although this meter measured, each day, a volume of gas considerably above that for which it was built, still, it absorbed only fifteen millimeters of pressure. On the first of January, following, one month after, it absorbed 170 millimeters of pressure. Its outlet pipe was lined all around (bushed, literally), with $C_{10}H_8$, its inlet, though spangled with naphthaline was, relatively, free from it. It is useless to say that the meter was filled with pure water. Why are the covers of the two purifiers spangled with sublimed naphthaline on the inside? Why is the surface of the material in the boxes covered with naphthaline? It is because the gas on leaving the boxes, saturated with aqueous vapor change of velocity finds a condensor with a large surface abandons a part of its aqueous vapor, and the proof that it abandons a part of this vapor is, that if the gas enters from above, the surface of the material is damp, wet, and that in descending through the interstices, the dampness diminishes, disappears towards the middle and reappears again below, near the bottom, which is a new condensor cooled by the soil, or the current of air in the cellar under the purifiers. Leaving these, naphthaline reappears, obstructs the outlets of the boxes, and its deposit, as I have said, goes on diminishing to the apparatus, which follows where the gas reabsorbs all the quantity of water which it has given up *en route*, gives it up again by condensation, and will deposit anew more naphthaline in some conditions, such that the first deposits of it which have taken place would not permit us to suppose that it ex-

isted still. The anaylsis of illuminating gas does not show the presence of naphthaline. I speak only of such analysis as have been made up to the present time, and do not refer to the new communications made by Mr. Berthelot, to the Academy of Sciences, which permit us to believe that illuminating gas is only composed of vapors. The experiments of Pitschke, cited in Schilling, are the only ones which established the existence of naphthaline in gas. I shall discuss these experiments further on. It is easy to prove that the $C_{10}H_8$ which Pitschke has found, did not pre-exist, and that the nature of the conditions to which he submitted the gas, had given birth to it for him. Analysis of gas shows the presence of ethylene, of butylene, of acetylene, of marsh gas of the oxide of carbon, of carbonic acid, of hydrogen, of nitrogen, but *not* of naphthaline. Naphthaline does not pre-exist, then, in gas. It forms itself there, and under certain influences. No more does benzine pre-exist in gas, for it would dissolve the naphthaline in it, either that which the gas contained, or that deposited in the pipes; analysis, moreover, does not show its existence in it. However, in the street mains we find naphthaline in dangerous proportions, and in the drips we detect the presence of benzine. Both are produced under the same circumstances, and under the same influences, but with this difference always, that naphthaline can be produced from benzine, and that benzine cannot be produced from naphthaline. If I establish this parallelism between the two bodies, that is, that the igneous reactions of which I have spoken above, make known the relative relations existing between them, and that it is thus that I happen to establish the production of naphthaline in the gas, and consequently that it did not pre-exist there. I will describe an interesting fact that I have observed, and that I think it necessary to make known.

Upon one of the main outlet pipes of my works, whose diameter is 350 millimeters (14 inches), I have had a branch at a distance of 1,200 meters from the point of departure, a new condict of 300 millimeters in diameter, which is supplied only from a single point and at intermittent periods. In one place, this pipe, which was only .80 C. below the surface, de-

scended, by necessity, to a depth of four meters (five feet), and this for 700 meters nearly to its junction. The syphon that this difference of level necessitated was always filled with a blackish liquid, very rich in benzine, while the syphons at the outlet of the works, and of the main pipe which supplied this branch, gave only water with some traces of light oil. This tends to prove that the gas that sleeps, so to speak, in this pipe of 300 millimeters, unused at certain times, and sometimes for long periods, undergoes certain influences in which time also acts, gives birth to benzine, and that it did not pre-exist since, through all the course of the gas before the point, that is to say, for a length of nearly two kilometers (five miles), we find in the liquids of condensation only mere traces of benzine (C_6H_6). I have said that the experiments that I made established the fact that gas, entirely dried, entirely deprived of aqueous vapor, could not deposit naphthaline. The following are the experiments:

1st. I took upon the same current of gas, two branches, one which conducted the gas in its ordinary state, in the other it passed successively through three flasks containing each one kilograme of chloride of calcium, in such a way that the gas was entirely dried. When the first flask became wet I renewed the chloride of calcium that it contained. The gas from each of these two branches followed the same course in glass tubes, kept parallel, which were joined to a series of Liebig tubes, which were plunged into the same salt bath, kept constantly at a temperature of 70° Cent. Upon leaving the bath the gas circulated in parallel tubes and entered a new series of Liebig tubes, plunged in the same receiver filled with ice, and sometimes with a refrigerating mixture, at the outlet of which, after passing over an identical course, I caused the dry gas to absorb water by simply flowing through it. The gas thus restored to state of ordinary moisture returned by similar tubes to the first, into the same salt bath which it passed through, in like Liebig tubes. I reproduced, in this way, in an exaggerated form, what actually occurs in practice, the gas passing suddenly from a high temperature to a very low one, and changing velocity in consequence of the change in section of the pipe.

It is useless to say that I operated upon gas perfectly purified, and that the quantities of gas with which I experimented were equal.

This experiment lasted for a month, and that, too, in the same month of December that the same gas produced an engorgment from naphthaline, in the outlet of the station meter of which I have spoken. That upon which I experimented was taken off before it arrived at this apparatus. Let us look at the results. I never obtained a trace of condensation, or a trace of naphthaline in the tubes through which the dried gas passed. I did obtain condensation, and always naphthaline, not only in the tubes where the gas was not dried, but also in those tubes where the gas dried at first had given none, but had retaken moisture from the last flask.

I think this first experiment conclusive, and I add that the dried gas had gained in illuminating power, as was easy to forsee.

Second Experiment—As I said before, naphthaline made its first appearance in my works, in a considerable quantity, upon the surface of the purifying material in the boxes, and upon the interior of the covers. One of these, in particular, permits the crystallization of naphthaline to take place in proportions, such that we cannot think that the naphthaline was produced far away, for it would all have stopped there if this naphthaline had pre-existed in the gas. I divided this box in two parts. In one of these parts the oxide of iron was left as usual, in the other part I put a layer of oxide of iron 20 centimeters thick, and then placed quicklime upon this for a height of 20 centimeters. At the end of several days I raised the cover of the box. The surface of the half of that I had left in the ordinary condition (the oxide of iron part) was literally covered with naphthaline, and the corresponding part of the cover was spangled with it.

The part where I had placed the quicklime had not a trace of naphthaline, and the half of the cover over the quicklime had not a trace of it. The box was worked equally in other respects, that is to say, that below the 20 centimeters of lime, upon leaving the point where the whole box was filled with

oxide of iron in the ordinary state, the material was blackened equally over the whole surface of the box, and at the same height. The lime was partially slacked by the water of the gas which it had absorbed. Thus, the surface of the material and the cover of the box, showed the contrast of being upon one part, entirely dry and free from naph haline, while upon the other part, naphthaline was perfectly sublimed in brilliant and moist particles.

A third experiment, which is a reproduction, upon a large scale, of the first, is now in progress, but I cannot now make known the results, as I intend to make it last for several months.

I feel authorized to quote from a letter that I have received from one of my colleagues, the manager of a large works, in which the purification is by lime exclusively, not quicklime, but lime slaked in powder, and susceptible still of absorbing a considerable quantity of aqueous vapor. I quote literally from this letter, which was not written by request, the author being ignorant of my experiments, and the theory which flows from them. "I must tell you, first of all, that my condensing apparatus is sufficiently powerful, and that, consequently, deposits of naphthaline sufficient to produce an obstruction in the ordinary working are very rare. My purification is still entirely by lime. I have little or no naphthaline at the inlet or outlet of my purifiers, and it is only from sense of duty that I overhaul this part of my pipes once a year.

"I have more of a deposit at the inlet of the station meter, and *above all at the outlet.*"

I underline these last words, which confirm my statement, that naphthaline is produced at the outlet of an apparatus in which the gas is saturated with the vapor of water, and when it gives up this vapor by condensation. The influence of condensation of aqueous vapor contained in the gas upon the production of naphthaline is then evident, and demonstrated by these experiments. This is the third cause, of which I spoke at the commencement of this memoir. It is only explained by the reproduction in the mass of the gas of reactions,

analogous to the igneous reactions which I have described above briefly.

The gases of which illuminating gas is composed, under certain influences, notably those of heat, as found by M. Berthelot, are changed into other bodies, and by a series of inverse decompositions and reciprocal displacements, produce benzine, and from that, naphthaline. If chemists can by the aid of appreciable forces, cause bodies to react upon each other, decompose them and form them again, these bodies, placed in favorable conditions, with smaller forces, can naturally, so to speak, cause the same reactions and produce the same new bodies that Science has created with means less powerful. Is not, moreover, the condensation of aqueous vapor a source of heat? Does not the vapor or water in condensing abandon all the heat that has been absorbed by the change of state from water into vapor, otherwise called the latent heat of vaporization? And cannot these quantities of heat thus restored, in the mass of gas, play the same role as the heat with which igneous reactions are produced? Would not the reactions which change marsh gas into ethylene, ethylene into acetylene, acetylene into benzine and styrolene, styrolene and acetylene into naphthaline, benzine and ethylene into anthracene and hydrogen, anthracene and ethylene into naphthaline and benzine, etc., etc., cause a disengagement of heat if they were produced; and the condensation, either of benzine or naphthaline, would it not cause the giving up to them also the latent heat of vaporization of these two bodies? Is not the impact of the gas in the pipes also a source of heat, which, although inappreciable to us, could favor the reactions of which I speak.

I spoke of the experiment of Pitschke, who found that "in causing gas to pass through a serpentine glass tube, about 9 metres long, filled with chloride of calcium, and cooled to 18°C., benzine and naphthaline were separated, the first especially in a quantity very appreciable (the second $C_{10}H_8$ was not, it appears, in a very appreciable quantity), "then, that in passing ether through the gas, and evaporating, he obtained benzine and naphthaline."

I am not surprised at this last fact, for ether dissolves the

hydro-carbons, notably, ethylene; the benzine and naphthaline could thus have been produced either during the act of the dissolution of the hydro-carbons in the ether or during its vaporization. The experiment could only be conclusive upon the condition that benzine and naphthaline were exclusively the only hydro-carbons which, existing in the gas, were soluble in ether. As to the first experiment, it would not be conclusive to me. In order to produce benzine and naphthaline "first, especially in quantity, very appreciable," it is necessary to pass a certain quantity of gas, and one can easily describe the difficulty of filling a serpentine glass tube, of which the diameters are generally very small, with the chloride of calcium. This would lead us to think that the gas which Pitschke examined had not been always thoroughly dried—the drying of the gas being a very delicate operation. If it had not been thoroughly dried, the condensation of aqueous vapor by the refrigerating to 18° has produced, as I have indicated, the naphthaline which was deposited. The same chemist produced nitro-benzine, by passing gas through fuming nitric acid. He does not say that he produced nitro-naphthaline, which he would easily have distinguished from the first by their different properties. The nitro-benzine solidifies at 3°, and nitro-naphthaline only at 43°.

Refrigeration alone does not cause deposits of naphthaline, and it is an error to think that the personal experience, which I have cited above, proves that cold produced naphthaline. It was only produced because the condensation of aqueous vapor is more abundant in winter than in summer; but as the gas is, by the cold more easily deprived of its aqueous vapor after the condensation of it does not produce itself. I read in Knapp's Chemical Technology: "At all times we find cases where, in spite of refrigeration carried to —20°C., we cannot obtain any naphthaline."

Before closing, although the considerations which follow do not relate directly to the theory which I maintain, I think it is well to explain why the deposit of naphthaline is not always found at the point where the condensation of aqueous vapor takes place. The naphthaline is produced in this place, but it

is not deposited there always, because, as the flakes are very light, and drawn along by the current of the gas, they are deposited where, by a change of velocity, an obstruction, a bend, the gas finds an eddy, or, so to speak, a time of arrest; or, where it meets a material obstacle, the rough sides of the pipe, for example, then wherever it has been deposited by any one of these causes whatever, it forms an obstacle of itself to the naphthaline, which the gas carries along, and holds in suspension, and little by little the deposit augments at the point, its flakes accumulate, one upon the other, upon the whole periphery of the pipe. Often, in house services and street lanterns, during severe winters, the water of condensation freezes, and the crystals thus formed constitute the mateiial obstacles which stop the flakes of naphthaline, which otherwise would be carried to the burners. To sum up: The production of $C_{10}H_8$ is due to the distillation of coal at high temperatures, but this is entirely dissolved by the contact of the gas with the tar and light oils which contain it. The production of naphthaline varies with different coals, and the constituent element of the gas may differ with the coals also.

The more that a kind of coal contains, as elements constituting illuminating gas, of marsh gas, ethylene, acetylene, styrolene, and anthracene, the greater will be the proportion of naphthaline that this kind of coal will produce. The production of naphthaline, after leaving the purifiers, is due to reactions which I shall call intimate, which take place (produce themselves) in the different elements that constitute the gas; the condensation of aqueous vapor causing these reactions—or, at least, these reactions do not take place, or, rather, naphthaline is not deposited when the gas is entirely deprived of aqueous vapor. This being admitted, I have only to describe the means that I have employed to accomplish the desiccation of the gas, which is too simple to require a long description. This process, the application of the above theory, I have patented.

At the outlet of the purifiers, as they are already established, the gas passes through one or more boxes filled with an agent that has a great affinity for water, quicklime, potash, soda,

baryta, etc., etc.; the hydraulic joint, if the seal is thus made, is produced by means of any non-essential oil. The syphons are filled with oil; in fine, upon the water of the gasometers is a bed of oil some centimeters in thickness. After passing the outlet governor, for more safety, the gas passes through some columns or boxes filled with the agent having an affinity for water, adapted in the first apparatus. The street syphons are filled with oil like those at the works.

A serious objection arises here. The consumers' meters would rapidly have the water-line lowered by the gas which arrived dry, and consequently, with great affinity (avide) for water.

It will be necessary to use others, or to adjust their level oftener. This, at any rate, would be an inconvenience very trifling, compared to those resulting from the deposit of naphthaline, which, at certain times, either about the works or in the canalization of the city, are of so grave a nature that they might compromise the services of manufacture and of the public lighting, and also cost the gas companies considerable sums —sometimes entirely a pure loss. I shall be happy to have found, if not the first cause of this evil and the remedy for preventing it, at least one of the causes, and to have demonstrated and indicated a simple proceeding which allows to remain in the gas the elements which, at a given moment, produce naphthaline; but which (not producing it) contains tribute to the illuminating power of the gas, and are sold, in place of being a nuisance and a loss. This evil is thus changed into a triple source of benefit; the expenses caused by searching for, and the labor for combatting the obstructions become useless; gain in illuminating power; increase in the sale of gas by a volume corresponding to the quantity of naphthaline crytallized and lost.

Thirdly. The results obtained, and the means used for the prevention of the deposit of $C_{10}H_8$, are as various as the localities where it occurs. They are all based upon the solubility of $C_{10}H_8$ in tar, or in the application of some of the tar products which are solvents for it, to those parts of the works where it is supposed to form. By prolonged contact with tar, as

by the friction, scrubbers, etc., good results have been obtained, though these even cannot overcome more than a certain amount, as there is a limit to the absorbing power of the tar.

In some works an immediate use of large quantities of enricher is resorted to as a cure, and, generally, with success for the time being. Sometimes this enricher is in the form of cannel; sometimes some form of petroleum put into the retorts, with the caking of coal, removes the trouble, and, then, again, these are tried and fail. I have been told that, in the manufacture of gas by the Tessie du Motay process, where from five to six gallons of naphtha used per 1,000 feet of gas produced, instances have occurred where naphthaline had formed and completely choked a six or eight inch pipe in the works itself; and, from the reactions spoken of by M. Bremond, may be found an explanation of it.

Another method for preventing it, is sprinkling benzine upon the purifying material after the boxes are filled. This, it is claimed, is efficient; but I have known of instances where it did no good. You have all heard the paper by our friend, Mr. Curley, of Wilmington, Del., which gives you the facts in his case, and his system would seem to commend itself to your most favorable consideration; but if the naphthaline forms itself spontaneously at any point of the manufacture after the scrubber, and also in the distribution, when the proper conditions therefor are presented, we shall still have trouble. If M. Bremond is right, and his experiments, which I have read, are vouched for by well-known and reliable witnesses, it would seem that in his method was to be found great aid in freeing you all from this troublesome $C_{10}H_8$, viz.: To deprive your gas of the watery vapor which it contains, and keep it so till it reaches the burner. The means he used to prevent the retaking of aqueous vapor was by using oil, in his purifying seals, his station meters, his syphons, and on the surface of water in the holder-tanks.

A more simple method might be to have a box of quicklime for the gas to pass through, after leaving the valve-house, just as it enters the mains for distribution.

With the means in use for freeing lamps from wood, alcohol, naphtha, etc., you are all familiar.

Thanking you all for the careful attention you have accorded to this already *too long* paper, I close with the hope that it may be the humble means of directing your minds into channels of investigation that shall prove of permanent value to the profession which you represent.

When Capt. Dresser concluded, he said: I wish to apologize to you, gentlemen, for keeping you so long. I tried to cut this down, but the more I tried the less able I was to do it, and I finally thought it would be better for you to have it just as it was.

MR. FORSTALL—I don't think Capt. Dresser need apologize at all, for I am sure we have all been very much entertained.

THE PRESIDENT stated that Mr. Goodwin had an apparatus for testing gas, which he would be glad to explain to the Association; and upon motion it was decided to request Mr. Goodwin to make an analysis of gas with his apparatus during the evening session, provided there was sufficient time left after the discussion on the various papers yet to be read.

The Convention then adjourned until 7 o'clock, P. M.

EVENING SESSION.

The members of the Association convened at 7.30 P. M., and were called to order by the President, who said:

Gentlemen: when we took our recess, we were on the subject of naphthaline, and the meeting is now open for discussion, remarks and questions. I am very glad the subject has been presented to us, and very glad we have had two or three papers read. Naphthaline is a great nuisance, and is getting to be more and more so. It makes considerable expense to the company by requiring a large force, who have to be paid for their work; but that is a matter of no great consequence—but when it annoys our consumers to the extent that it has done, putting out lights in a store, or a church, for instance; or, when a per-

son tries to light the gas in his house, and finds no gas, and he may be a long distance from the office, and it may be very difficult for him to find any one—therefore, I say, I feel the annoyance resulting from naphthaline to our consumers more than to ourselves; and if we can find any radical cure for this naphthaline, then all the expense and trouble we have incurred by coming here will be paid back ten-fold.

MR. WOOD, of Syracuse—I would like to know how general this complaint is? Over the central part of the State of New York, from the Hudson River to Buffalo, we hardly know what it is. We occasionally have a little in the service pipes, but very little; and I am informed that it is so in Albany. We use the best of coal, and we are not troubled to any extent with it. I know there is a good deal of time spent at every meeting on this question of naphthaline, but to me, it seems a waste of time.

THE PRESIDENT—I have met gentlemen, and in speaking to them on the subject, they have said: "Why, I don't know what naphthaline is." Six months afterward I have met them again and asked them if they knew anything about it, and they have said—"Oh! don't mention it; we know well enough now what it is." So, Mr. Wood, you are liable to be attacked at any time.

MR. MCILHENNY—I don't know that I can throw one ray of light on this mysterious subject; but I would like to dispel what little mystery there is between the papers which we have read. Mr. Curley proposes to vaporize the naphthaline in the retorts. and carry it along so that it will not be deposited. In the paper read by Captain Dresser, it was proposed to remove the aqueous vapors by dry lime used on the purifiers.

CAPTAIN DRESSER—Not lime, but chloride of calcium, or something of that kind, on the purifier, and subsequent box.

MR. MCILHENNY—I did'nt try this experiment; but I want some simple, practical way; and I think it could be used on one, two, or three trays of the purifier. That is one method of preventing it, and the other is to fill the meter with benzine.

Captain Dresser—Any non-essential oil. The object is to prevent the contact of the gas with the water after it has been dried.

Mr. McIlhenny—My object is, to put it so that it can be distinctly understood, how to do it. There are, then, two ways—one, the use of quicklime in the purifier, and the other, and most convenient and simple, is to use any light oils to flow on the top of the water and prevent the gas from absorbing moisture.

Captain Dresser—It is not two methods—they are used together. The object of the first is to dry your gas, and the object of the second to keep it dry. It is all one process.

Mr. McIlhenny—Well, I simply wanted to reduce it so that any one here could try it, if necessary. All you have to do is to use the lime on a part, or the whole of your purifier, and then use the oil in the manner I have stated.

The President—Suppose you use the lime on every tray of your purifier. What is the result?

Mr. McIlhenny—I don't know; I never tried it. Well, you use lime just the same, but it is a different lime.

Mr. McElroy—On seeing this process explained in the *Gas-Light Journal*, I determined to give it a trial, and the only way I had to do it, was to fill one tray with quicklime. I thought I would have an opportunity to experiment before coming to the meeting, but, unfortunately, the box held out longer than I expected, and I had no chance to see the effect, consequently, I cannot give it to you. Naphthaline has been a great annoyance to me, and one of the worst things about it is, that you don't know where or when it is going to strike you. It is like the measles—you all have to have it sometime. Why, at one time, I had 270 complaints out of 5,500 consumers, and I certainly think that anything that can be projected here to cure this annoyance will amply repay us for coming here. I have tried everything. I have covered my purifiers with lime, and sometimes I would succeed, and at other times it wasn't worth shucks. [Laughter]. I got up an instrument for vaporizing benzine without bringing it into contact with steam, and

during the greatest consumption, in the evening, I would pass that right into the main with the gas, and that, heretofore, until this year, had the desired effect. I could always kill the monster in two nights, but this year it got me down, and got stronger every night. [Laughter]. But the morning I left home to come here I only had eighty calls, so it is getting better. I was in hope I could try this desiccation process. I have a tar pipe in which all the tar and drip from the retorts pass. This is an inch pipe. I have a three-quarter gas pipe, with steam at about 80 or 90 pounds pressure, and you can't hold your hand on that pipe, so that, if there was anything in that, I think I could drive it off. It has been in operation for six months every day and night, and it don't reach the trouble, so I don't give much for that. [Laughter.]

Mr. Lindsley—I feel a good deal interested in this subject. For three years I was ignorant of naphthaline, but learned to my sorrow afterwards what it was, to the extent of having from four to six inch pipes stopped up with it at various times. For the latter part of that time I would use the test guage to discover it, get behind it, apply fire, so the heat would go forward in the direction of the gas, and, in that way I have thawed it out ; but Mr. McElroy has occasioned me a momentary pang. [Laughter]. I have labored for some little time under the delusion that I had a good thing, and I thought I would communicate it. I will not give any scientific plan, but relate my experience. I have sprinkled my purifiers with benzine for two years, and had a steamed gas main ; and, in addition to that, I have had a pan, six feet long and three feet across, near the inlet, and for the last two years I have had but very little trouble. so that I did think naphthaline didn't amount to anything after all. Once in a while it indicated its presence, but I would send the boys around and dispel it, so that for two years, I have had a good time; but Mr. McElroy has frightened me considerably. [Laughter.]

Mr. McElroy—I didn't include light tars in my heater, so there is some chance for that yet. I have dissolved naphthaline with steam, and, at first, I thought it was a bully thing (laughter); but afterwards I found I could not get anything to

wash it out. Put benzine in, and boiled it; the result was, I had afterwards to pump out the boiled benzine. In short, I find when I keep my yield up to 5, or 5.20, I can't cure it, unless this desiccation process will cure it; but if I reduce it down to 4.95 then I can handle it with benzine. Above that—I can't control it.

MR. COGGSHALL—What was your production, Mr. Wood?

MR. WOOD—Our average yield for twelve months is five feet to the pound.

THE PRESIDENT—I have used cannel coal and had naphthaline; oil-naphthaline; Penn-coal naphthaline; and several years ago I was making gas with iron retorts, less than three feet to the pound, and had naphthaline.

MR. RANKIN—I would ask Mr. McElroy, if any vapors are engendered at the same time with the gas.

MR. MCELROY—Water of distillation is certainly present, as it comes from the retort house.

MR. CURLEY—I can easily understand why that is, from the fact that he gets such a large yield, If I could run off five feet, naphthaline would make its appearance. My production, per ton of coal, is 10,800 feet of 17 candle gas. If I run up to a larger quantity of gas, I deprive it of all light vapors. When they are decomposed they add very little illuminating power to the gas: they increase the volume somewhat, but very little; but I find that a small quantity of vapor mixed with the gas, make it six or ten times more valuable, as illuminators, than the same vapor decomposed in the form of gas.

CAPTAIN WHITE—I will supplement Mr. Curley's remarks with a little of my experience, which I will leave as a legacy to the Association. My gas averaged nearly 17 candles for two years, with a yield of 11,000 feet to the ton of coal, and I used nothing but West Virginia coal—no enriching material. The method used was something similar to Mr. Curley's method. The process was simply to first use a friction scrubber—a very simple affair, consisting of a series of boxes with perforated screens—a series of screens. I carried all the regular products from the hydraulic main into these boxes. The gas left the re-

torts under the action of the exhauster, and passed through these boxes, passing through the screens, and so breaking up the molecules, and the vapors were received by the gas and mingled with it as it went along. The process was simply that and nothing more. It went on through the ordinary process, the purifier, etc., and we never knew what naphthaline was, and never had any trouble about the illuminating power. The gas was always over 16 candles. Another gentleman, who had no interest, whatever, in the process, tried it with the same results that I obtained. I concluded, when I was going to leave the company, for certain reasons, to take that thing out. I did so, supposing my successor would take charge of the works this month, but he did not come, and—note the result. In two nights after I had taken out that scrubber, I had a hundred people in the office calling for gas. They had no light. A few days ago I got mad; went out and purchased some coal oil, mixed it with saw dust, and stopped it up, and as long as I kept my production at five feet, or a little less, I had no trouble whatever.

It is all very well to pass it through dry lime, and grease your mains, and all that kind of thing; but if you go to work and put that scrubber in your works (and it won't cost you more than $100) you have a solution of the whole thing. And it is a gain to your companies, too. We have not had to purchase any high-priced coals, and have saved all the labor of going around and cleaning out the service pipes. A few thousand dollars look better on the dividend account than on the expense account, and there is where I managed to keep it while I had that scrubber.

Captain Dresser—I would ask if there was any change in the temperature about the time you took that thing out—or any other reasons which might have accounted for the results?

Captain White—Yes, sir; while the weather is regularly cold, or regularly warm, there is generally no trouble; but changes in the weather give trouble. But while we had this box I speak of, we never had any trouble whatever—no difference what the changes were. There were changes about the

time I took it out, and I don't suppose if the weather had been regular there would have been as much annoyance.

Mr. Forstall—You feel satisfied that if the box had remained in, there would have been no trouble?

Captain White—Yes, sir; perfectly.

Chas. H. Nettleton—I rise to corroborate what Messrs. White and Curley have said. About six months ago my attention was directed to an article, by Mr. Young, which I thought over very carefully, for a week or so, when Mr. Curley's pamphlet came around, corroborating what Mr. Young had said; and I immediately commenced the process, putting steam through the tar in a box, making it run from the box out of the bottom by a syphon pipe, which kept it full of tar. That was in February. I cut down my cannel one-half. The first day or two the gas was a little poor, but it picked up; and, through the summer, we only used one-half as much cannel and had equally good gas. My works are very small, and I had been doing very poorly. I gradually increased the yield until it reached 5 feet, but that was too much. I now run 4.80 and 4.90, and my gas will run from 17 to 18 candles. Before that I would see considerable quantities of naphthaline in the purifier house; but since that I havn't seen a particle, not a single drop in any of my pipes. In regard to what Mr. McElroy said about heating the tar; while on my journey here, I talked with Mr. Young, and he said, "be careful not to heat the tar too much." If you run the temperature too high it will drive off the heavier tar and that will condense the naphthaline. I found that Mr. Young has a way of accomplishing the same result, even more simple than mine; and, as he is here, perhaps he will give it to the Association.

Mr. Young—My experience is pretty much the same as Mr. White's and Mr. Curley's. Recently we have commenced utilizing the ammoniacal liquors. I put up a little pump and pumped the ammoniacal liquor back into the mains, and I noticed a little improvement in the gas from the ammoniacal liquor. One day I had omitted to pump the tar out of the well, and it rose up into the suction pipe of the pump which was used for the ammoniacal liquor. I noticed considerable improve-

ment in the illuminating power of the gas. Previous to that we had used the residuum, as we called it, about three or four parts, mixing it up with saw-dust. I went out to the foreman, and asked if he was using more tar than usual, and he said no. I asked him if he noticed any improvement in the gas, and he said he believed it was better. Upon investigating I found that the pump was pumping back tar through the hydraulic main; and from that day to this we abandoned the use of oil altogether to keep up the illuminating power, and we now get from 16½ to 17 candles, according to the heat; but, of course, if we run our yield up to five feet, we diminish the illuminating power. Since I adopted this practice I havn't seen a trace of naphthaline, and I have no trouble to keep my gas up, in that way, to 17 candles. I consider the use of tar equal to two and a-half or three candles. Using nut coal and slack, I get 4.60; lump coal, 4.80 and 4.85.

THE PRESIDENT—It will be necessary, now, for us to pass on to some other subject; so there will be another paper read. Unless some gentleman is very anxious to continue this discussion, I will call upon Mr. Somerville to read his paper.

MR. JAS. SOMERVILLE, of Knoxville, Tenn., then read the following paper on

THE DEFECTS OF THE GAS GLOBE AND HOLDER.

I have long held the opinion, and I am sure you will all agree with me, that any improvement we can suggest, or effect, that will have a tendency to make the gas we manufacture and sell more economical, agreeable and beneficial to the consumer, just to that extent will it be the more agreeable and beneficial to us, and the companies we represent here.

Therefore, holding these views, as we do, it has been thought that the subject of the defects of the ordinary gas globe and holder merited from us some consideration, with a view to their improvement.

A gas globe, I take it, ought to combine utility with ornament. As they are at present constructed the utility is entirely left out, with the exception of some kinds of opal globes, which have some points of utility, but none of ornament. It is

a source of constant annoyance to the gas engineer to see the sixteen candle gas which he has sent to the consumer, dwindle down to eight or nine candles, by the use of the common globe and holder.

His sensations, when observing this, are similar to those of an artist, when, in the exhibition rooms, he sees his best painting hung in a miserable light, or, rather, the merits of the painting obscured by the frame. But the painter is wiser than we are, for his greatest anxiety, after completing the picture, is that it shall be seen and admired to the best advantage.

And so it is with every other profession and trade; the greatest care and skill is exercised by the manufacturer and merchant, so that the articles they produce and sell shall be seen by the purchaser in the most favorable light.

Take, for instance, the kerosene lamp-maker; observe the ingenuity and art he has displayed in bringing his lamps to such perfection, that every particle of light the oil will give is consumed to the best advantage, and the burners and shades are so admirably arranged that the rays of light are directed to the very point where they are most required. Can we say the same as to gas-lighting? Is it not a fact that in the room where gas is used, the ceiling is often, I may say invariably, the only place well lighted. Can it be said that the maker of gas lamps has displayed skill and ingenuity in so arranging his globes and shades that the gas is burned to the best advantage? We are forced to admit that the reverse is true. Hence it is that the kerosene oil lamp is a dangerous competitor with gas. Who of you, have not witnessed, time and again, the gas flame inside the globe, flickering, wavering and dancing, as the cold air rushes through the narrow orifice, impinging against the light, causing it to smoke at the points, and destroying half its value, while the agitated flame allows a portion of the gas to escape unburnt, which produces that perceptible odor of gas in most of our churches and halls.

I have a faint hope that perhaps the expression or action of the Association upon this subject, may induce the manufacturers of globes and holders, to make them more adapted to the purpose for which they are intended—viz., to impart steadiness

to the flame, and direct and allow the rays of light to reach that point where they are most required, and, at the same time, to be ornamental. I say a faint hope. For a number of years I have been looking for, and expecting, a globe of this description, but in vain; they change not. It would appear that they were beyond improvement, that they were unalterable—for it is a fact that the ordinary globe remains the same to-day as when first invented.

Improvement is the order of the day. Every industry is awake to, and applying it; but gas globes remain the same rarefied air producers, the same flame agitating machines, they ever were. And this is all the more surprising, when we consider that the improvement, or remedy needed, is so simple, so effectual, and so costless, that we wonder it has not been effected long ago.

The first and greatest defect of the ordinary globe is its two inch opening at the bottom; this diameter is just two inches too small. What reason is assigned for this narrow opening? Why it was fixed at that size, and why it remains so, I am totally unable to conjecture. But it is this defect that produces most of the trouble which I have described; and, as if this opening was not already too small, the maker of globe holders, who, it appears, is in hearty sympathy with the globe manufacturer, contrives still more to contract this opening and obscure the light, by furnishing the globe with what is, I suppose, meant to be an *ornamental* holder.

You are all familiar with it—observe these three little holes for the air to get in—observe also what precaution is taken so that none of the light shall get out—look how the metal is spread out at right angles to the light—observe with what reluctance the maker has left even the three little air holes!

The globe holder ought to be constructed only of three prongs of brass wire, not over one-eighth of an inch thick, and any additional strength required ought to be put parallel with the downward rays of light, so that it will cast no shadow.

No rim whatever is required to the holder; the prongs ought to be so fashioned at the ends as to receive the rim of and support the globe.

The globe ought to be made with its bottom opening never less than four inches in diameter, and from seven to eight inches diameter at its widest part. These dimensions will allow the air ample passage through the globe, without striking against the flame, and will actually have a tendency to steady the light, which is the greatest *desideratum*. It will also allow the best form of burner to be used, and the rays of light will have ample scope to strike downward to the place where they are most required; and, in short, the consumer will get the full benefit of the light. All globes ought to have a space of three inches of clear glass round the bottom, and in ornamenting and flowering, the maker ought to have this one end always in view, to intercept the rays of light as little as possible.

Opal and ground glass globes ought to be entirely discarded, when it is known that they obscure from forty to fifty per cent. of the light. If the light requires to be toned, surely the most effective method is to *turn* it down; this method has also the advantage of being the cheapest. These opal and ground globes can await the event of the electric candle, which some people prophesy is not far distant. From what I can hear of the light the candle gives, they will be required then. In conclusion, gentlemen, if globes and holders are made and used as I have attempted to describe, we will have far less complaints of bad gas and poor lights, and I need not point out to you that the duty of attending to the wants of consumers, is becoming more and more our duty. We are the parties interested. Let us not always turn him over to the tender mercies of the gas-fitter.

I am of the opinion the *gas* companies are the proper persons to do the *gas* fitting.

My experience is that it pays well, in every way for the gas engineer to see that the consumer gets the full benefit of the light he is purchasing from us, as far as we are able to do, with the articles at our command.

I hope the wisdom of the Association may suggest some method of drawing the attention of the makers of globes and holders to the importance of this greatly desired improvement. It is to their own interest to effect it, for the use of the globe

would thereby be extended. Since preparing this paper, I observe the same subject, the defects of the globe and holder, is being ventilated in England. Let this country have the honor of being the first to adopt the improvement suggested.

When Mr. Somerville's paper was concluded, discussion of the same was called for by the President, and Mr. McIlhenny said:

I think, Mr. President, that we can all verify what Mr. Somerville says. I think he has presented the subject in a very able and comprehensive manner; and, certainly, we all should be interested in that subject. Every word he said is true, and I think if something can be done to cause investigation, it will be of great advantage to both the consumer and seller of gas; so that I hope the subject won't rest here, but having been opened it will go on growing until something is done.

A MEMBER—I think that article should be published in the newspapers of all the cities, so as to bring it before the people, and then they won't say that the gas companies are alone to blame in this matter.

MR. STARR—I would suggest that the paper should be sent to the makers. This could be done by forwarding the *Gas Light Journal* to them.

CAPTAIN DRESSER—We would be very glad to do so.

MR. MCILHENNY—I have little faith in the people adopting anything of that kind. About nine years ago I made a pretty comprehensive statement to the people, in a series of experiments I made with globes and burners, and I didn't see any results in the community. The only way it can be accomplished is through the globe manufacturers. If you simply want the public to adopt them without their help, you can't accomplish your object.

CAPTAIN DRESSER—I will make a statement on this subject. I presented this matter to one of the leading gas companies of New York, and asked them why they didn't endeavor to get the globe and fixture makers to furnish such a globe as would burn gas to the best advantage. They said they had tried it; had applied to the leading manufacturers in New York, and their reply was that it wasn't the fashion, and the ladies wouldn't have them.

Now, you have to manage some things in one way, and with others you can do better to manage in another. Some of the members of the Association have great influence with the ladies, and they must take the lead in this matter of shades. They must make the ladies believe that it is the fashion to have a wide, open-bottomed shade, and then there will be some hope for the gas maker selling his gas, and the consumer getting value received for the money paid for it. (Applause and Laughter.) .

CAPTAIN WHITE—After the extended remarks of the worthy editor of the *Journal*, I may be allowed to give my experience among the ladies. I had a laughable experience. I was in the service of a company some years ago, that, among other things, wanted the storekeepers to understand that a good 8 ft. burner in a window was better than two 5 ft. burners; so I went to work and made experiments, and found what the loss of light was with different globes and burners. One burner would utilize but forty per cent., and a shade destroyed thirty per cent. of the light, so that the light was very poor, even with good gas; I couldn't do anything with the storekeepers, so I tried the ladies. When I got talking with them, they wouldn't talk about anything but the gas and the bills, and how some friend had gone in the country, and his bill was just the same when he returned; but, after they got through, I would quietly take off one shade, and light the jet, shutting off all the rest, and they would be perfectly astonished, and they would exclaim, "Why; I never saw so much light in my life in this room. Why, there is no doubt about that—my dress shows so well; but then the chandelier looks so bare. I would rather have a ground glass globe, even if the bill is a little heavier."

Now we are introducing, in Brooklyn and New York, the use of a wide bottomed shade, with just the three straight brass wires for a support, that Mr. Somerville has referred to. I first used it in my house, and the people would come in from next door and wonder how in the world we ever managed to get such a light; and the popular opinion around there was that I ran a separate pipe from the gas works up to my house, but it was simply owing to the fact that I had put these new shades on. Those shades and burners gradually got through the neighbor-

hood where I was known, and they had good success; but it was bad success for the gas companies, for they didn't sell so much gas. There is no doubt to-day but that the companies must come to the point where they control the gas to the very point of burning, and dictate the size of the burners, and every thing else.

In Paris the people go to the company and ask for instructions, and they say what shade shall be used, and they are used, (and there is no city in the world so well lighted as Paris), and when our companies get a like control, they will have the same effect. There is no use making 17 candle gas for a man who has a lot of old brass burners, with one-third enough air supplied to them; and I find, among gas consumers generally, that they don't care for the size of the bill, if they can only get a good light.

Now, is it fair that a man should be compelled to burn four or five lights in his parlor when we know that two burners would give him all the light he wants?

MR. STARR—I have had some little experience in the same way. We have been annoyed in our place with burner patents, and the result was we had a great deal of dissatisfaction, and I finally adopted the plan of furnishing all consumers with the best burner I could get, and now when a man has a house built he comes to the office and gets the burner. I use a double chamber burner, and I think in the last year I have put on fifty gross of them with nine hundred consumers. The people come to us to get burners, and it has had this effect—that while other gas companies have been falling off, we have always increased, but it has had another effect, and that is—it has reduced the bills very materially, which is one reason why I use it.

MR. GRAY—What size is that burner?

MR. STARR—I have different sizes. I recommend for the kitchen, a three foot burner, for the sitting-room a four foot, for the front hall a two foot, and for chambers also a two foot burner, as giving better results than any other. We have 0.3 pressure at night and 0.2 in the day time.

Mr. Coggshall—I adopted the same plan of furnishing burners. A few years ago I got up a pamphlet showing the difference in burners, and at the same time offered to furnish burners for just cost, and at present I furnish burners for all the people in our place.

Mr. Stedman—I would like to ask if the use of the large bottomed globe is becoming fashionable?

The President—It is coming into very general use; but now, gentlemen, if you are ready for the next paper, I will call upon the author to read it.

Mr. L. P. Gerould then said that as he was suffering from a severe cold, he would ask Captain Dresser to read his paper for him. The paper was read as follows:

ON LEAKAGE FROM STREET MAINS AND CONTROL OF THE SAME BY STREET MAIN VALVES.

By L. P. Gerould, Engineer of Newton and Watertown Gas Light Company, Newton, Mass.

I desire to call the attention of the members of the Association to a very important part of gas works, which, I think, has not, heretofore, received the attention it deserves; indeed, I am sure, that in many places, it has been altogether neglected. I refer to street main valves.

In the early history of the construction of gas works, we have reason to believe that the value of these auxiliaries to street mains was appreciated, and that the use of them was only abandoned when it was found that those which had been introduced could not be relied upon to close when occasion required, owing to the rust which had accumulated about the working parts exposed to air and moisture, rendering them useless. In evidence of this, we have the clumsy substitutes, which, in some instances, were resorted to, of drip boxes or water valves, with partitions extending near to the bottom, forming a part of the main, which could be sealed by partially filling them with water, and thus cut off the flow of gas, and which could be restored by pumping the water out again. The

habit, however, was formed of dispensing with valves in the extension of mains, and in the construction of new works. Even in modern times they have formed no part of the plan of distribution, notwithstanding that modern improvements have entirely done away with the objection to their use, and that their present mode of construction renders them entirely reliable when they are needed to cut off the supply of gas from a street or district. A large part of the whole of the gas works in this country have been built by contract, many of them by persons or companies of limited means, and, in most cases, it is presumable, to make the cost as small as possible, and hence, perhaps, it is, that in so few places, the engineer has any control over his gas after it is admitted to the mains for distribution.

No water-works are constructed without gates to control the flow of water, enabling the engineer to cut off the supply from a district in case of breakage of pipes, or need of repair. The same should be the case with gas works, and for the same reason, perhaps even with more force, namely to avoid the waste and damage to property, and loss, even, of life.

Cases have come within my observation, and I presume within the observation of many who hear me, of very considerable leakage in mains from defective joints, and from breakage; in some instances of a percentage in gas so large as to materially diminish the profits of the company; cases where there has been great difficulty in determining the position of breaks or leaking joints from local causes; such, for example, as proximity to, or crossing a common sewer or drain, a loose, gravelly soil, in which the pipes are laid underlying a compact stratum of clayey soil—a pavement more or less close, or a layer of frozen ground; or, where from such or other causes, a horizontal passage is afforded for the escaping gas, by which it escapes detection altogether, or is carried to a distance from the place from whence it makes the escape from the pipe, rendering it impossible to determine, without great expenditure of time and labor in digging down and laying bare the pipe, where the defects are to be found, in order to remedy them. Many instances of this kind might be cited, some of them involving long continued and serious loss; but probably every gas engineer will recall some one or more such cases as having come

within his notice, and I need not, therefore, dwell any longer upon the subject.

The introduction of a proper system of street main valves affords for these evils the only remedy. With them, the engineer is enabled to determine what parts of his mains are defective, and the exact loss sustained by such defects, and to remedy them, and until time is afforded for remedying the defects, he may, by closing certain valves, shut off the particular district in which the leakage is occurring during the day time, or all of the hours when the gas is not needed, and thereby avoid a considerable part of the loss which otherwise would be sustained.

It is, however, when large fires take place in cities, that sudden and great losses are sustained, from want of suitable means to cut off the gas from the burning districts, that the importance of street main valves is most evident. At such times the loss of gas to the company is often very great, even greater in amount than would have been the cost of all the valves necessary on all the mains, yet small in comparison with the loss of buildings and other property, occasioned by its combustion from ruptured distributing pipes in the apartments of the buildings, which afford a continuous combustible for a flame which is not extinguishable by water. But the loss by fires thus occasioned is not the only danger to be apprehended from gas escaping from ruptured pipes in such cases, for there is always liability of its escaping in confined cellars, and other apartments, where it has not the means of becoming immediately ignited, but mixing in the air in proportions to render it explosive, becomes an element of still greater destruction.

Instance might be cited where millions of feet of gas have been lost in a single fire, where for nights a whole city has been shrouded in darkness, and where entire buildings have been destroyed by explosions from admixture of air with escaping gas, which otherwise would have escaped the flames of the burning district, occasioning instantaneous loss of property, and what is far more serious, loss of life. With the means at hand for preventing such lamentable occurrence—or avoiding such dangerous risks—it is not a matter of question whether any gas light company is justified in neglecting to take precautionary measures

for avoiding such calamities, by placing valves in their street mains, in such positions as will enable them at any time when occasion requires, to shut off the gas from any street or district in which a fire occurs.

In the report of the commissioners appointed to investigate the cause of the great fire in Boston, in 1872, it is said: "The fire, like all great city conflagrations, was greatly aggravated by the escape of gas from the burning buildings. The fall of heavy warehouses broke the main pipes, and on Monday morning the escaped gas in the services exploded and caused another fire, which destroyed a million of property and cost two lives. The officers of the gas company believed that their water valves were sufficiently powerful to cut off the supply of gas, as they had proved to be hitherto, but found that the belief was an error.

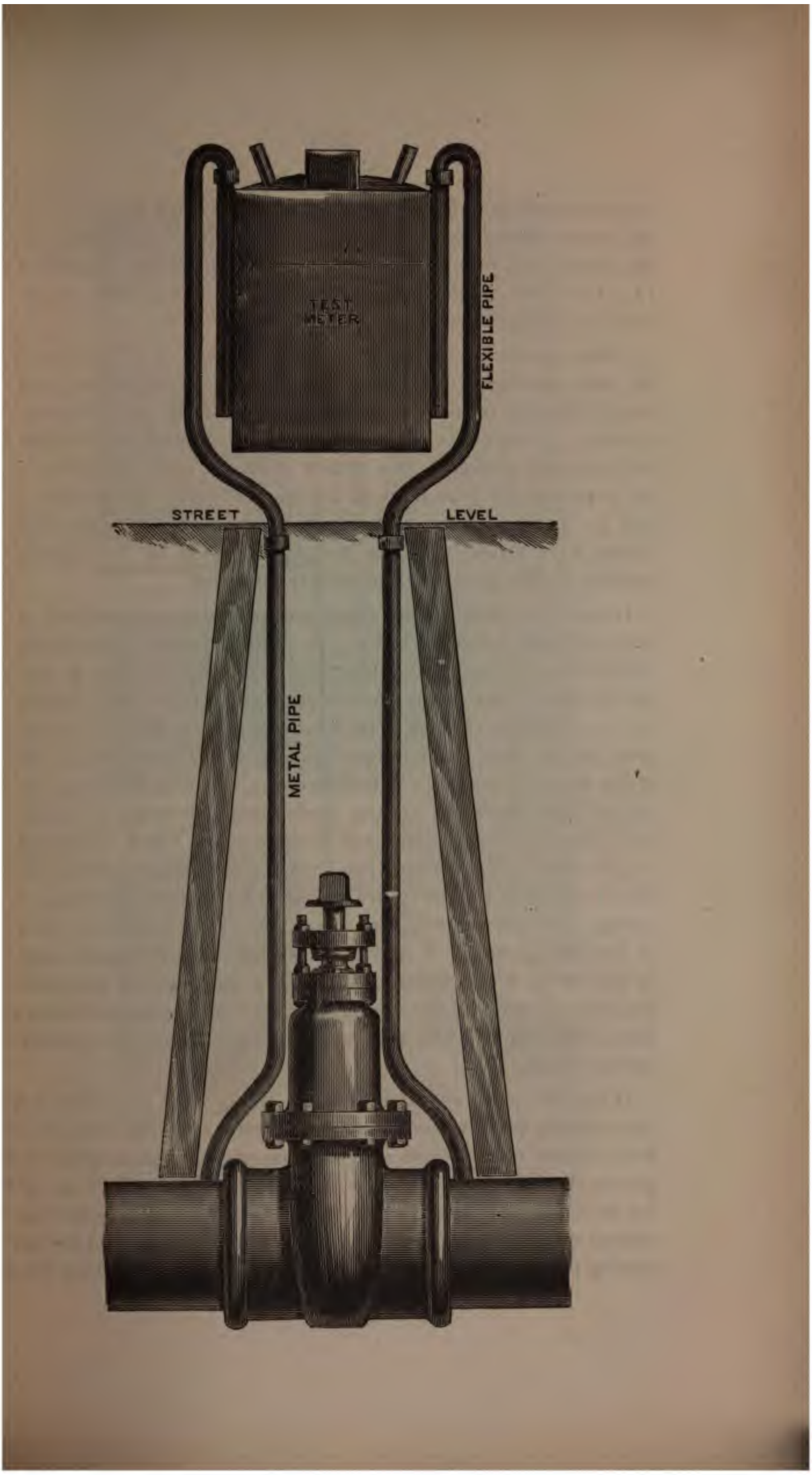
"The lack of valves properly constructed, and so placed as to isolate the burnt district, led to terrible loss, exposed us to the inconvenience and peril of total darkness during two nights, and endangered the whole city. The company have undertaken to repair this error by providing sliding valves. The risk arising from the impossibility of isolating a burning district should never be incurred again."

Since the great fire, the Boston Gas Light Company have placed in their street mains over seventeen hundred sliding valves, to control the passage of gas.

LEAKAGE.

I have prepared a plan to illustrate some trials I have recen ly made, to determine and to remedy the waste of gas fro street mains connected with works under my charge. It sho a section in which there is laid down 43,500 feet of pipe, fro which the supply of gas can be cut off by a single valve, th position of which is shown on the plan at No. 1.

In determining where a leak is to be found, I use a mete specially constructed for the purpose, with a dial on the top divided into tenths of a foot. Connection is made with the mete by flexible pipes, on each side of the street main valve, as shown in the drawing, so that the valve being tight, any gas escaping from the main beyond it must pass through the meter. In the

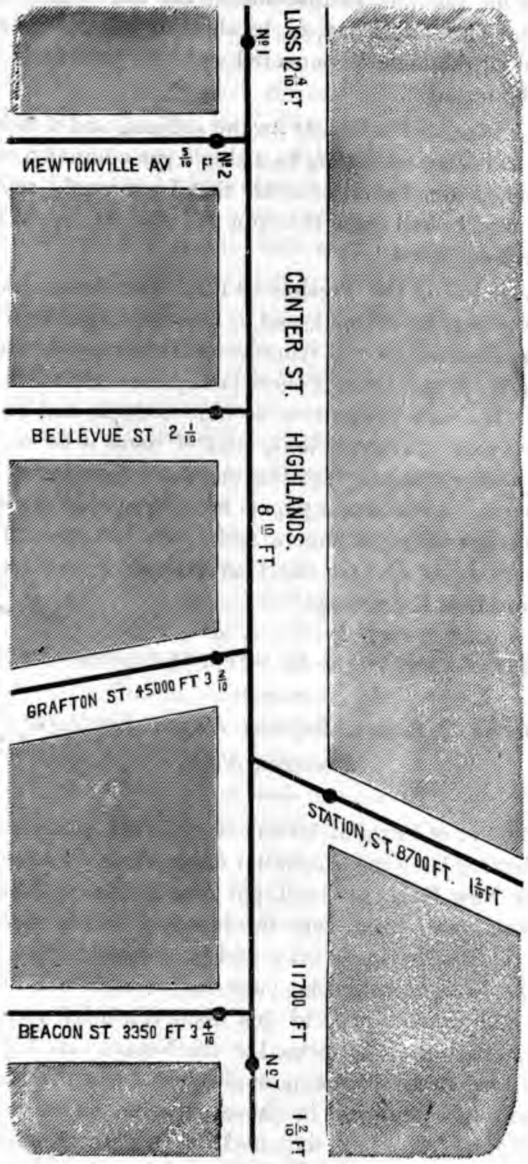

TEST METER
FLEXIBLE PIPE
STREET
LEVEL
METAL PIPE

trials referred to, I first made a connection with the mai the manner described on each side of valve No. 1, the valv ing closed, and found that in ten minutes the meter regist 12 4-10ths feet, equal to 74 4-10ths feet per hour. This, t was the leakage beyond that point.

I then connected the meter in the same way on each sid the valve marked No. 7 on the plan, this plan being closed, found that 12-10ths feet passed through it in ten min equal to 7 2-10ths feet in an hour. This showed clearly the principal leakage in this section of mains, must be bet the points on the plan marked by the two valves number and 7. In this manner all parts of the main between the valves were tested with the results indicated by the fig marked on the plan, and the defects remedied.

It is evident that by the same means we may determi any particular valve is tight. As a consequence of the t referred to a large saving has been effected, not only in but in labor. Before the introduction of valves in our m our cost for repairs upon them was from $800 to $1,500 pe num, on less than thirty miles of pipe! Since that time, b of the means described for finding leaks, this cost has bee duced below $400 per annum upon forty-five miles of r while the loss from leakage and condensation, which aver 18 per cent. on the former (less than thirty miles), has bee duced on the latter (forty-five miles) to 8 per cent., showi saving of 10 per cent. of gas on an increased length of of over 50 per cent. I may here remark that the entire of the valves in the mains was less than $1,000, and that has been covered by the saving in labor in detecting and r dying leaks during the past year, irrespective of the gr saving of gas.

It may be urged as an objection to the method describe determining the position of leaks in mains, that in many tricts it may not be applicable because of the consumpti gas on the line of pipes in the day time, or during the tin the trial, but this may be obviated by keeping a registe several days, of the gas consumed at a given time, and d mining the average consumption, or better, by requesting


LOSS 12 4/10 FT.
No 1
NEWTONVILLE AV 5/10 FT
No 2
CENTER ST. HIGHLANDS.
8 10 FT.
BELLEVUE ST 2 1/10
GRAFTON ST 45000 FT 3 2/10
STATION, ST. 8700 FT. 1 3/10 FT
11700 FT
BEACON ST 3350 FT 3 4/10
No 7
1 2/10 FT

consumers on the line to discontinue the use of gas during a certain hour on a given day, or by shutting off the gas at such time, from all the meters connected with the particular line of mains to be tested.

I trust I have said sufficient on the subject, and if it leads to effecting an important saving to a single gas company, or a saving of a single life, I shall consider that I am amply repaid for my labor, and I shall trust that you will also be repaid for the time I have occupied.

At its conclusion the President said: Gentlemen, there are two more papers to be read, and it may be expedient to dispense with discussions and remarks until after these two papers have been read, and then, if there is any time, devote it to discussions. We meet to-morrow at nine o'clock, and have only two hours, until eleven o'clock, and if there is no objection, with the understanding that the members can recur to this paper after these remaining papers have been read, we will proceed with the reading of papers, and I will call upon Mr. Benson to read his paper "On the Temperature of Retorts at Different Periods of the Charge."

TEMPERATURE OF RETORTS AT DIFFERENT PERIODS OF CHARGE.

By Frederick S. Benson, Engineer Nassau Gas Light Company, Brooklyn, N. Y.

The subject of heats of retorts at different periods of their charge, having been made a matter of record at the annual meeting of the New England Gas Light Association in February of the present year, from data furnished by M. S. Greenough, Esq., of the Boston Gas Works, and published in the *American Gas Light Journal*, vol, xxvi, page 102, it might not be out of place to add another page to this history, a brief account of a series of experiments performed at the Nassau Gas Light Company's works, Brooklyn, being made the subject thereof.

The settings employed in these experiments were clay retorts, 14" × 26" × 9 feet, sixes and are what is commonly known as skeleton, viz., a barely sufficient quantity of brick and tile to

properly support the retorts, and no more. These benches being so widely dissimilar to those used in the experiments at Boston, mentioned before, afford a fair comparison between the two theories of setting retorts, one assuming that the least quantity of brick and tile used, after the retorts are properly shielded from the direct action of the flame on the former is more profitable. thus leaving the retorts to more quickly recuperate from the effects of a fresh charge of coal, or of cleaning the furnace fire, and attain their maximum temperature, although they may show a lower temperature during such time.

The other, that a larger amount of brick and tile employed in the setting is more favorable, from the fact that such tile serve to store or accumulate the heat attained during the later portion of the charges, and, in so doing, retain the heat of the bench at a more equitable temperature, or with less sudden variation, during the operations of charging retorts or cleaning fires.

There can be no question as to the theoretical damage to retorts by a constant rise and fall of temperature of any great extent, yet, practically, such variations as were shown to exist by the experiments about to be explained, were not worth taking into consideration, and it will be shown by the following data, that such large variations, or extremes of temperature, as might be expected, or that have commonly been supposed to exist are not obtained.

The same general apparatus and formula were used in this case, as well as weight and description of coal as that used in the investigation mentioned before, that the results might be compared as to the different settings, and as the apparatus and formula may not be fresh in the memory of members, I will venture to explain them.

Two pieces of iron were used, weighing as nearly five pounds each as possible: these were round, and provided with an eye in the end to facilitate their withdrawal from the retort. A frame or truck to slide these irons to about the centre of the retort, and on the top of the charge of coal; the object being to have them as nearly as practicable, in the same position in the retort in every instance; these trays were supported by legs in

the mouthpiece, and by two standards in the rear end. A galvanized iron receptacle for holding forty pounds of water, two standard thermometers accurately divided, two wooden paddles to agitate the water in the iron box, that it might be of even temperature throughout, and hooks to remove the irons from the retorts while hot, and transfer them to the water for immersion.

The process consisted in placing the trays for the irons into the retort after it was charged with coal, with one of the irons on the same, a wire hook attached to the iron, and coming out so far front as the lid, and closing the lid.

At the expiration of thirty minutes the lid was struck (this operation being rendered comparatively easy by using the patent Eureka lid), another hook inserted into the eye of the hook already in the retort, and the iron drawn forward to the front of the retort, the first hook was then allowed to drop to the floor, and it was carried to the water and immersed, at the same time a fresh iron was substituted in the retort and the lid closed.

The average time that elapsed from the time the lid was opened till it was closed for this portion of the experiment was twenty-eight seconds, and the average time from the instant of opening the lid to the time the iron was immersed in the water was ten seconds. It will therefore be seen the iron had those ten seconds to part with a small portion of the heat, but as this was a constant quantity throughout the series of experiments, a fair comparitive result could easily be obtained.

Before the immersion of the iron the temperature of the water was carefully noted, and after the immersion the rise of temperature of the water as indicated by the thermometer, carefully observed.

When the iron was exactly the same temperature as the water, which was ascertained by placing the back of the thermometer in contact with the iron, a note was made of the water's temperature.

The following formula was then used to ascertain the maxi-

mum temperature of the iron (supposing the temperature of the retorts to be the same) :

$$T = W \frac{o - t^{\circ}}{w\,x} \times O$$

in which T = temperature of retort.

W = weight of water.

C = temperature of water after immersion.

t — temperature of water before immersion.

w = weight of iron.

x = specific heat of iron.*

*Assumed to be .126

At the date of the first experiments there were but four benches under fire—three on one side of the retort house and one on the other. Of these the middle bench was selected, having a working bench on each side, and one at the back, thus giving a fair result of any bench, should they all have been under fire. The two middle retorts were selected for the experiment, it having been shown by trial that they were a fair average heat of the whole bench.

The first trial was made on Friday, July 20, 1877, commencing at 11.30 A. M, or thirty minutes after the charge had been made.

The bench was charged with 1380 lbs. of coal, 230 lbs. to each retort, of which 50 per cent. was Block House from the Provinces (very fine), and 50 per cent. Penn (good run); two irons were used, one being placed in the same retort after the first was withdrawn, and thus alternated during the whole four hours of the charge; each iron was therefore exposed to the heat of the retort thirty minutes.

The temperatures obtained were as follows:

½ hour after charging,		. . . .	1.437° .5
1	"	"	1.585° .5
1½	"	"	1.730° .5
2	"	"	1.776° .0
2½	"	"	2.009° .0
3	"	"	1 920° .5
3½	"	"	1.953° .5
4	"	"	1.929° .5

Average temperature of whole four hours, 1.793°.

The falling off of temperature at the third hour of the charge may be attributed to a fresh charge of coke in the furnace fire, which was made just before that time; but the decline in temperature at the fourth hour, or at the end of the charge, when it is commonly supposed the retort would attain its maximum heat, is not so easily accounted for.

The yield of gas per pound of coal, during this experiment, was 5.34 per lb.; 11,962 cubic feet per ton of 2240 lbs.; and the production of the bench in 24 hours, 44,214 cubic feet.

By reason of the small consumption at the date of this experiment, four benches were somewhat in excess, and three as much behind our needs. To obviate the necessity, therefore, of missing charges on account of filling our holders, the plan was adopted of reducing the charges of coal in each bench to as much as would yield the requisite amount of gas, and the amount at that time used, 230 lbs. to each retort, was largely behind what the benches would carbonize, if necessity required.

It will plainly be seen, therefore, that as far as the average, or common amount of work performed by the retorts, the above experiment was in no degree a fair statement. To remedy this, and obtain results when the retorts were carbonizing, the charge of coal customarily used, viz: 260 lbs. (although at the present date 270 lbs. are being used), another series of experiments were inaugurated on July 24th, after the bench had fair time to attain an increased temperature necessary to carbonize the additional quantity of coal.

In this experiment, dry Penn coal was used entirely, to more nearly attain the same conditions under which similar experiments mentioned before had been performed. The same bench as before was selected and the same retorts, the exceptions being a charge of 260 lbs. of coal instead of 230 lbs., as before.

The results obtained by this latter experiment, were as follows:

Temperature	½	hour after charging,	. . .	1.632°
"	1	"	" . . .	1.728°
"	1½	"	" . . .	1.858°
"	2	"	" . . .	1.918°
"	2½	"	" . . .	2.114°
"	3	"	" . . .	2.147°
"	3½	"	" . . .	2.179°
"	4	"	" . . .	2.179°

Average temperature of whole four hours, 1969°.

In this case the furnace was refilled on the second hour of the charge, with but a small decline in temperature, as compared with the previous experiment, and also, the temperature was sustained to its maximum till the end of the charge.

The amount of coal used in this instance, as before mentioned, was 260 lbs. of dry Penn, (run of the pile) to each retort. For whole bench, 1560 lbs; yield per pound, 5.59; per ton, 2240 lbs., 12,522 cubic feet. Production of bench in twenty-four hours, 52,322 cubic feet.

The following deductions are made from these results:—Extreme variation of temperature in first experiment, 516°; in second experiment, 547°, showing that although 13 per cent. more coal was used, the additional temperature was but 6 per cent. while the increased production was 18 per cent. In each instance the amount of coke used in twenty-four hours, per bench, was fifty bushels, or 41 per cent. of the whole amount manufactured per bench in twenty-four hours.

THE PRESIDENT—The next paper, and the last, is that by Mr. C. A. White; but before proceeding with that, I wish to

say here that it is proposed in the morning, as the names of the members are called, to ask them to state the amount of capital paid in by their companies, so that we may know the amount of capital represented here. I see no reason why any member should object to that, as we don't ask for the indebtedness, or bonds, or anything but the amount of capital paid in; but if any member does object, he need not tell what the amount is, of course.

Mr. C. A. White, of Rochester, then read the following paper on the

CARE AND MANAGEMENT OF WORKS:

Valuable papers have been read before the Association, at its previous meetings, on the selection or choice of site for the location of works, and have been the means of bringing out rich thoughts that have benefitted all. Perhaps, no one of us but has been repaid, and amply so, for the time devoted to study and practical research, which its discussion necessitated.

The question is one of deep moment, not alone to us into whose hands its oversight must fall, but to those who are more intimately connected with its construction; involving, as it does, the matter of economy, in building, of manufacture, and dealing especially with the pressure necessary for distribution. These are, indeed, questions of depth and weight, and, as such, cannot be thrown lightly aside when we are called upon to consider the subject of construction.

But, while this is strictly true, have we not overlooked, what may have seemed a minor point to many of us, that after our site has been chosen, our works have been erected, and we are ready to begin business, we have never given the matter of management and care of our works a single thought.

We have prepared, argued and debated, time and again, the major premises of construction, and, without ever thinking of the minor premise of management—have endeavored to force a logical conclusion of results.

No point can be logically argued without its premises, nor can results be laid down or premised without, not alone study and thought, but practical knowledge derived from both, as to the proper manner of managing our works.

The subject of care and management of works appears, upon first thought, to be simple in the extreme, in fact, too much so to warrant the consideration of the Association, and yet, the the longer we dwell upon it, the deeper we endeavor to fathom it, the grander the subject becomes, until it assumes the almost colossal proportions of being the one thing absolutely essential for the success of a gas company.

While I do not propose to give the plan pursued by myself, nor to dictate to you, gentlemen, the manner in which your works shall be conducted; for modesty forbids the one, and to pursue the other course would be presumptuous, I do wish to bring the subject before you as one that I deem worthy of the greatest consideration.

In the review of our subject, the retort house presents itself as the first and the essential point. Upon our care in the initial step in the process of manufacture, depends our success; so much so is this the case, that the retort house may well be termed the keystone of our profession, for, though work well done there, may be, to a certain extent, impaired in the processes of washing, condensing, etc., nothing in the latter stages of manufacture can be done that will recover what may have been lost by neglect at the beginning.

Newbigging has well placed among his golden rules "Keep up the heats in the retort house;" and high heats are now almost universally acknowledged to be one of the great essentials in the destructive distillation of coal; producing larger returns per pound of coal carbonized, and yet, at the same time, has its evil attendants.

In addition to the heats, I deem economy in the work of the retort house a matter of the highest moment, and one most likely to bring about tangible results. I do not mean that false economy that shuts the spigot and leaves open the bung-hole. I do not mean that we shall pay our men niggardly wages, but I do mean that we should dispense with all useless and superflous men, that we shall pay those we retain fair, living wages, and exact in return therefor, an honest day's labor; for, while in the former case our yields may be good, the wages of the men employed adds materially to the cost of production; while in

the latter case we have a fair yield, with but a small labor roll; and it is possible to have good heats with but few men, as they then have an opportunity to do their work thoroughly, the result is not a falling off in manufacture, but an increase, and that at a reduced cost.

But this is not to be obtained without honest endeavor upon our part. We cannot entirely trust the key of our position to our laborers, be they ever so competent or worthy. Nature makes us imitative creatures, and, being such, if we who are in charge of works give, as it were, a passing thought thereto; if, as in case with too many of us, we merely take a morning and afternoon stroll through our retort house; our men being, as I said, imitative, will soon feel that we are not deeply concerned in its management, and will drop into a slow, come-easy style of work, which cannot fail of proving detrimental to the interests committed to our charge. On the contrary, do they see we are alert, calling them strictly to account for any dereliction of duty, they will soon feel that their interest and ours are common, and will work earnestly for their advancement.

It is not possible, in the limits of such a paper, to mention all the devices and plans which have arisen, for the purpose of increasing the results in the retort house, nor is it my intention to dwell upon them, be they good or bad; for though many have been tried in the balance, and found wanting, many yet find admirers.

There is, however, not a doubt in my mind but that, wherever practicable, improved machinery, that has been thoroughly tested and proven good, should be introduced as tending to lessen the cost of manufacture; but, so far, there has been a great hesitancy on all sides to abandon the bridge, which has so far carried us safely, and launch out upon a vast sea of uncertainty; we are in this respect much like unto the children of Israel, crying out for a Joshua to lead us.

Those of you who have been ever led to experiment with any "improved processes" for the carbonizing of coal, or improved apparatus for scrubbing, condensing, etc., etc., know full well that the great drawback which has prevented your arriving at any safe or honest conclusion as to its value, is the fact that

you have no detailed statement of results from the old or different methods with which you make a comparison—there has been entire lack of detail in one or both cases.

Heretofore, the main object in all such experiments has been to produce so many feet per pound of coal, with possibly a slight leaning to a record of illuminating value, and, mayhap, an occasional note is jotted down of the working of the exhauster. No attention has been paid to the processes of purification, to the atmospheric influences, nor to the many minor details which go so far to make success or failure a certainty.

So long as this mode of experimenting is continued we can look for no real or beneficial results, as it is but seldom that all the conditions, that a series of experiments with one and the same apparatus, had at different places, will accomplish the same results. This being the case, it is necessary, would we have our work prove of any value to ourselves or others, that a correct record of everything entering into the success or failure of our experiments be kept, for then, and then only, can they, by reduction to adopted standards, be used in comparison with work accomplished by others.

These records prove of value, not alone in comparing results of experiments, but in our every-day work. It is not just to compare our yield per pound of coal with that of another, and, because we may have succeeded in obtaining a few hundredths of a cubic foot per pound more than he, claim that our results are better, when, perchance, were the truth known, it was the other way. It is thus easy to see that the necessity of strict attention to details enters not alone into one, but into every point of our economy, and is a matter that should receive serious consideration, as being the most likely to bring us to a proper plane of comparisons, even to that varying and troublesome question "unaccounted-for gas."

It is not my purpose to enter into and discuss the several details or processes now being used in the purification of gas; should I do so I might be deemed the outrunner of some of the many patentees; this being the case I shall only add that unless the care which has been exercised in the early stages of manufacture follow, the increased results we have there obtained, closely to the end, they may be very materially diminished.

There is one subject to which I think all of us should give close attention, as being one most likely to repay us in the increased illuminating value of our gas—and that is, what is the proper temperature of condensation? The old axiom that "thorough condensation is half purification" is one of but little value to us to-day, simply because no one can tell us what "thorough condensation" means—that is, what temperature constitutes or fulfills the meaning of the word "thorough."

Experience has taught us that rapid or sudden condensation is a great evil; and yet, to-day, works are constructed in which the gas is plunged into a water bath not ten (10) feet from the hydraulic main and, not content with this shock, is led into condensers not two feet further on; the only wonder is that there are any illuminants left in the gas when it reaches the holder. In connection with this thought let us look for one moment at the proper temperature of registering at the station meter—this, as well as photometrical observations, etc., has always been allowed as 60° Fahr., with the barometer at 30 inches.

Now, if this be the proper temperature to represent gas at its standard volume, surely thorough condensation cannot mean a temperature below that point, but some point so much above it only as will lose the additional degrees of heat in its passage to and through the purifiers.

At my works I endeavor to keep the temperature at the outlet of my second condenser, at 70°, the gas then reaching the meter at or near 60°.

We are well aware that all aeriform bodies expand 1-480 of their bulk, at 32° Fahr., for every additional degree of temperature, or about 1 per cent. for every 5°, consequently the temperature at which the make of gas is registered and distributed from the holder, would, if carefully observed, go far to dispel some of the gloom which seems to pervade our heavy leakage account. For instance—a ton of coal yielding 10,000 cubic feet as registered at 60°, would, if registered at 70°, increase to 10.196 cubic feet, quite an item to the credit of manufacturing account; but if the gas is distributed at 60°, it falls back to 10,000 cubic feet, and we are obliged to place 196

feet to leakage account—this, added to condensation in mains, goes far to make up the major portion of our "unaccounted-for gas.

It is thus but too apparent that what may seem the minor details of our works are among the most important, do we look for solid results, and though such small nothings are apt to prove annoying and vexatious, at the outset, if they are honestly and thoroughly adhered to, will go largely to ensure success, and it is this minutiæ, more than all else, that requires our personal supervision, for while our foremen may be faithful, yet it is hard to instil into their minds the necessity of so much care over few degrees, more or less, in the temperature of the gas.

Gentlemen; if cleanliness is next to Godliness, methinks there is no place in which it is more necessary than at a gas works. No time is squandered that is devoted to the cleaning and care of machinery, rather does it repay, in its better working, all such labor; I can conceive of no reason why the engine, exhauster, etc., should not at all times put on holiday attire. Order in the retort house is more than law, and its results apparent on every hand. Not alone this, but the floors, from the retort house throughout, should be kept scrupulously clean. The old saw—"a place for everything, and everything in its place," was, methinks, especially given birth to for our benefit. There are two reasons for this—the one, when the tools are needed there may be no delay if they are properly placed—the other, by it we instil in our men a feeling of pride.

I care not what manner of men we may have around the works, if they are in any wise fitted for the labor they are called upon to perform, if they are early taught that their place must be kept clean, they will soon come to pride themselves upon the appearance of the space before their bench, and a rivalry as to who shall be the cleanest will be the result.

Again; while I am not here to read an essay upon landscape gardening, I do feel that too many of us who have the yard room neglect to care for it, but leave it as a dreary waste, an eyesore to all who may happen our way; a few moments in the day will soon put our yards in shape. Let the heaps of old iron, broken barrows, and such like, that are now piled up as

monuments to neglect, be banished, and let grass-plats take their place—add a few flowers, and let it all be done by your own men during leisure moments—under your supervision, and you have brought them into contact with a refining influence which cannot fail of good effect. Not alone this, you awaken a feeling of pride; they look upon this change as the result of their labor, they have an interest in it; and, believe me, but a short lime will elapse until they are as deeply interested in its success, if not more so, than yourself.

There are many, I know, think this fancy, gentlemen; practical experience has demonstrated to me that it is truth.

Others may say that it is expensive; to this I reply—not necessarily so.

If you aim to complete all your plans at once it will necessitate the employment of outside labor, would prove costly, and, worse than all, would rob the thing of its charm. Simply take a small portion at a time, complete that, plant your flowers, and you have laid down the foundation stone of what shall prove a source of pride and pleasure, not alone to you, or those who may visit you, but to your employees; and, more than all, you have won them without a seeming effort, to greater neatness and despatch in all their work.

Well does Matthews say, in speaking of details in business, "does not experience prove the sagacity of these observations? In the case of gifted men especially, what cause of failure do we find more fruitful than that here indicated? Their souls fire with lofty conceptions of some work to be achieved; their minds warm with enthusiasm as they contemplate the object already attained; but when they begin to put the scheme into execution, they turn away in disgust from the dry minutiæ and vulgar drudgery which are required for its perfection. Hence the world is full of mute, inglorious Miltons, who languish, not from lack of ability, but because, in spite of their many brilliant parts, they lack something which the famous possess."

Thus we see, gentlemen, that constant watchfulness in all departments of our profession may well be added to the list of golden rules. Our lives will be indeed spent, or rather misspent, in planning grand improvements, unless we are willing to watch

with a patience doubly told every detail, not alone of its construction, but its useful management and working.

We can no more look for success, by neglecting the minutiæ of our profession, than can the general, who, while he may plan some grand achievement, hope for victory to perch upon his banner, when he leaves the entire detail of his campaign to subordinate officers.

History never fails to repeat itself, and the methods of success in years gone by were the same as those of to-day.

In conclusion, gentlemen; if to the patriot of old "eternal vigilance was the price of liberty"—to us eternal watchfulness is the price of success. Would we win results from the works in our charge, ours must be the brain to devise, ours the wisdom to direct and the thoughtful energy that shall overcome all obstacles, and snatch, as it were, success from apparent failure; and while history may not carry our names with sounding praise to future generations, perchance, a satisfied board of directors may, for a moment, dwell with kindly remembrances on the man who has spent himself in their service; but over all, and above all, will and must come to our minds that satisfaction, that rest of conscience that ever follows a full and faithful performance of duty.

The President—I was mistaken about Mr. White's being the last paper, but before we hear the remaining paper read, I will state that there is an application for membership from Mr. R. C. Terry, of Philadelphia, and Mr. Cartwright moves that the secretary be authorized to cast the vote of the Convention for the gentleman.

The chair then appointed Capt. Dresser teller, to receive the ballots, which was done, and Mr. Terry was declared duly elected as a member of the Association.

The President—There should have been a report of the Committee on Statistics before now. Has there been such a committee appointed?

Receiving no response to this question, the chair proceeded to appoint Messrs. McIlhenny, Henry Cartwright and A. B. Slater, as a Committee on Statistics.

MR. HENRY CARTWRIGHT then moved that the reading of the remaining paper be dispensed with until the morning session.

This motion was carried, and a motion for adjournment was made by Capt. White, which was seconded, but, by consent, was afterwards withdrawn.

THE PRESIDENT—I am ready now to entertain the motion for adjournment.

CAPT. WHITE then renewed his motion, which was carried, and the Convention adjourned until nine o'clock, A. M.

SECOND DAY.

MORNING SESSION.

The Convention assembled at 9.30 A. M., and was called to order by the chairman, who read the subjects of the last three papers to the members of the Association, and said: I owe an apology to those members of the Association who have been waiting here since nine o'clock; but a very important meeting was being held by the Executive Committee, and as presiding officer of that committee, I could not well leave. To tell you the truth, gentlemen, the time allowed us for discussion is too short. We ought to have had, at least, two whole days, and perhaps three. [Applause] Now, in the discussions of these last subjects, members must necessarily be very brief, so that we can accept the hospitalities of the Cincinnati Gas Light Co., at eleven o'clock. I trust in future we will have two days, and I would like it better if we could have three days, and then we would have plenty of time for all the subjects to be thoroughly presented. It was proposed that when calling the roll this morning, we ask each member, as his name is called, to give the amount of capital paid in by his company. There is a very small attendance this morning, and perhaps that matter better be deferred. What is your pleasure?

MR. STARR—I move that the roll is called at ten o'clock. Carried.

THE PRESIDENT—The first subject before you for discussion, if you see fit to discuss it, is, "Valves in Street Mains." Now,

be very brief, and speak to the point, and no member speak but once, except by permission of the Association.

MR. STARR—I will just say I have been doing that for ten years. We have fifteen miles of pipe, in which we have eleven valves, and we like them very much indeed.

THE PRESIDENT—If there is no objection we will lay aside the discussion until some business of importance is transacted. The first thing is the report of the committee appointed to prepare some suitable memorials upon the deaths of members.

CAPTAIN DRESSER, for the committee, read the report as follows :

Whereas, By the inscrutable wisdom of Providence, our fellow-members and co-laborers, Messrs. W. H. Perry, of Bangor, Maine ; Charles Collier, of Selma, Alabama ; and George T. Sutton, of Peekskill, N. Y., have been called from the varied and darkened cares of this world, to a purer and brighter home ; and

Whereas, It is but proper that we pay suitable respect to their memories,

Therefore Resolved, That, in their death this Association has lost interested and worthy members, whose decease we sincerely deplore, and to whose merit and true worth we hereby bear evidence.

Resolved, That we tender to the families of the deceased, our warmest sympathy in their bereavement.

Resolved, That a copy of these resolutions be spread upon the minutes, and a copy sent to the respective families of deceased.

W. H. DENNISTON,
WILLIAM DUNBAR,
WILLIAM A. STEDMAN.

THE PRESIDENT—I will suggest that a standing vote be taken as to the adoption of this report. As many as are in favor of adopting this report please rise. Carried unanimously.

The resolutions offered by the Executive Committee were then read in their order and adopted by the Association. They were as follows :

Resolved, That for the considerate attention given for the comfort and pleasure of the members of the Association, during the Convention held at Cincinnati, the hearty thanks of the Association be tendered to Gen. A. H. Hickenlooper, President of the Cincinnati Gas Light and Coke Co.

Resolved, That the cordial thanks of the Association be, and are hereby extended to Capt. G. Warren Dresser, Editor of the *American Gas Light Journal*, for his active exertions in promoting the interests of the Association; and to assure him of the hearty co-operation of the members to further the success of the *Journal*, by increasing its circulation.

Resolved, That the duties of the Secretary of the Association having been so satisfactorily performed by Mr. Charles Nettleton, it is but eminently proper that in appreciation of his invaluable services, the thanks of the Association are hereby tendered to him.

MR. MCILHENNY—I have an additional resolution to offer. I move that the sense of this Association is that our thanks be tendered our presiding officer for the efficient manner in which he has presided over our meeting. The motion was unanimously carried.

THE PRESIDENT said: I thank you for this token of your appreciation. I was very unexpectedly called upon to fill this position, and was not sure that I should discharge the duties in a manner becoming so honorable a position as presiding officer of this Association. I think we have had a very pleasant meeting, and I only regret that it will be so short. I have done my best to further the interests and business of the Association, and have been as expeditious as possible. I think we have transacted a great deal of business, and what has been said and done here will be of great benefit to the gas-light companies of America, not only those represented here but all others.

The proceedings of the meeting, the papers read, and the discussions, will all be printed in the *American Gas Light Journal*, so that every one will have an opportunity to read them. Again I thank you. [Applause.]

Mr. Denniston—The last paper read last evening was presented by Mr. Patton, I think, "On the price of gas." It is of too much importance to pass over in this hurried manner. There are some points worthy of considerable discussion, and I hardly think it proper that that paper as it is, should be endorsed by the Convention and given to the public as such. I, myself, don't feel ready to endorse it, and think the paper had better be laid over for another year, and I now move that the paper be left in the hands of the Secretary, to be re-read for discussion at the next meeting of the Association.

A Member—I would make this suggestion—that the paper be referred to a committee of our most intelligent gas men, and let them consider and report upon it at the next meeting. I would make it the Executive Committee, and let us hear from them.

Mr. Cartwright—It certainly is not desirable to have that paper come forth as our opinion, without more mature deliberation, and therefore I think it had better be postponed, without leaving it to any committee.

Mr. Denniston—This paper was before the Executive Committee, and it was not desired to choke any body off, but at the same time it was expected that there would be a discussion of the paper, and now that it would be impossible to give it the time it ought to have, I think it should be postponed. When the committee passed upon it, it was supposed that the paper would be fully discussed, and I think it should not be submitted to the Executive Committee without a general discussion.

Mr. Butterworth—I hope the motion will prevail, because we have had so many things of that nature that have not been necessary, that I would be very glad to have this paper discussed, and therefore I would like to have this paper postponed. Mr. Patton is not here to answer for himself, but I am sure he would be perfectly willing to have the paper go over.

Capt. Dresser—It seems to me the whole matter is very simple. As I understand it, this Association is not afraid to meet any question, but when they publish the proceedings to the world they want to publish both sides, and therefore it

seems to me to be best to lay this paper over for discussion. I think it an act of courtesy to Mr. Patton, as he is not here to answer for himself, and also that it will be serving the interests of the Association, to lay the paper over for discussion next year.

The motion was then voted on and unanimously carried, which laid the matter over until the next meeting of the Association.

THE PRESIDENT—The Special Committee on Leakage and Unaccounted-for Gas are now ready to report.

THE SECRETARY—If any gentleman present has suggestions on the subject we will be very glad to have them made here for the benefit of the committee, or furnished to the Secretary at any time during the year. The committee have nothing to report now, but ask that they may be continued until next year.

A MEMBER—Gen. Hickenlooper is now in the room, and I think it would be well for the President to inform him of the resolution passed by the Association.

The resolution was then read by the President, to which Gen. Hickenlooper said in response: I simply desire to say, of course you have my heartfelt thanks for the kind compliment, but I would suggest, as a matter of propriety, that the names of the directors of the Gas Light Company be substituted for my own, for it is through them that I am enabled to extend to the Association the hospitality of the city.

MR. FORSTALL—I move to amend the resolution by inserting the names of the directors of the Cincinnati Gas Light Company, in addition to that of General Hickenlooper.

The amendment was carried, and the names inserted by the Secretary.

THE PRESIDENT—I might, for your information. state, that the matter of printing the proceedings of this session came before the Executive Committee, and it was decided not to print them this year, but to print them for two years, binding them together. The expenses for one year would be nearly as great as for two, and as the proceedings will be printed in full in the *American Gas Light Journal*, you will all have an opportunity

to read them ; and I have no doubt a sufficient number will be printed, so that every one who desires can have one, two, three, or more duplicate copies as he may desire. Therefore, unless there is some motion offered to print, there will be nothing done with regard to this matter.

GEN. HICKENLOOPER—I would like to say to the members of the Association that the trip as expected to be taken, will render it necessary for us to adjourn promptly at 11 o'clock. I have made arrangements for a small drip on the main line, and I suppose there will be some little absorption there. [Laughter.]

MR. McILHENNY—I would like to say that if any gentlemen going home can make it convenient to go through Washington, I will be very glad to see them, and will show them the handsomest city in the world.

THE PRESIDENT—The roll call will now be proceeded with. Is the Committee on Tabulation of Statistics prepared to report ?

MR. McILHENNY—No sir, the committee are not ready to report, and ask for further time.

Upon motion further time was granted the committee.

CAPTAIN WHITE—The time for our adjournment is rapidly approaching, and if we are to hear from Mr. Goodwin on the subject of his apparatus, I think we had better get to work at once ; and I therefore move that we postpone discussion on the papers read, and listen to Mr. Goodwin. Carried.

MR. COGGSHALL—Before calling on Mr. Goodwin, I hope the chair will entertain a motion I have to offer, to the effect that the Executive Committee be authorized to extend the time of meeting to a three days' session. The motion was seconded, and remarks being called for.

MR. STARR—I have been a member, this is the third annual meeting, and my feelings were this year, that if I had to go to New York, with the hurried manner in which we have done our business, I would not have gone ; but if you take three days, I would go. I go to learn something, and I am very glad the motion has been made, and if it is carried I hope those three days will be devoted to business, and not to eating and drinking.

The motion was then voted on and unanimously carried.

Mr. Slater then moved that the thanks of the Association be tendered to those gentlemen who have presented papers to the Association, which was accordingly done.

Mr. Slater also suggested the papers which had been read "On Street Mains" and "On Competition," would be very interesting reading for the public, and he hoped the members, if they saw fit, would cause them to be published in the daily papers of their respective cities; and Capt. Dresser stated that if any of them wanted slips, he would be glad to furnish them from the office of the American Gas Light Journal.

Mr. Goodwin was then called on for a description of his apparatus for gas analysis. Before describing the apparatus, he said: I wish to say that I have no interest, whatever, in any patent process for the manufacture of gas, outside of coal. I say this because I have heard since coming here, that I am largely interested in some patent process, but it is entirely false.

REMARKS OF MR. GOODWIN.

Mr. President and Gentlemen, Members of the American Gas Light Association:

Heretofore, the apparatus, expense, time and knowledge of chemistry required in the analysis of gas have been very great, as compared with the method and apparatus I now propose to call your attention to; for instance, in the matter of expense. A professional gentleman having been employed to make an analysis of gas, expended on account of the company over one hundred dollars for mercury alone. The time used up in making the analysis covered several weeks, and the expense to the company was over one thousand dollars.

By the method about to be presented to you, the analysis could have been made within one hour—that is to say, so far as its *practical value* to the company was concerned. I do not desire to be understood as objecting to the methods of *exact* analysis as promulgated by Bunsen, Bowditch or Sutton. What

I claim is, that for all *practical* purposes the constituents of gas and their relative per cent. to each other, so far as their value to the gas man is concerned, can be determined at an expenditure of time and expense, infinitely small, as compared to the old methods, and within the general knowledge of any gas engineer. Your acquaintance with the variable constituents of your gas should be as positive as your knowledge of its photometrical value.

I claim this information is, or should be, of great importance to the members of this Association, particularly in these days of new and patented processes, or the manufacture of gas, which are constantly being brought before you, with a persistent urging of the purchase of the same, with the alternative in the event of a refusal on your part to buy; of the establishment of an opposition company in your midst, resulting in a gas war involving the sacrifice of large monied interests, animosity and bitterness of feeling. After the parties having these various processes for sale, urge upon you their claims and personal knowledge of how to furnish cheap gas for the million, with a persistance and tenacity really astonishing; when their actual knowledge of the practice and chemistry of gas making is considered. In these remarks, I wish to be distinctly understood, that I am not referring to any particular process or method, as their name is legion, but rather in general terms.

I claim for this new method of analyzing gases that it is an easy and rapid mode of determining the value of a process for gas manufacturing when brought before you, for, as already stated, the difficulty attending the solution of the question as to how much of this, that, or the other constituent contained in any given gas has heretofore been so great that weeks may elapse before an analysis can be completed, whereas, had the means been at hand for a short and easy manner of analyzing the products of new processes, possibly a less number of opposition companies might have been in existence to-day.

In the destructive distillation of coal the following gases are produced; Ammonia, (NH_3); Sulphuretted Hydrogen, (H_2S); Carbonic Acid, (CO_2); Air or Oxygen and Nitrogen; Bisulphide of Carbon, (CS_2); Olefiant Gas (C_2H_4); Acetylene, etc.,

(C_2H_2); Carbonic Oxide, (CO); Light Carburetted Hydrogen, (CH_4); Hydrogen, (H).

The first four of these gases on the list, although often present in well made gas, are generally considered impurities, and by right should not be there.

The apparatus will determine the presence of the above gases and their quantity.

The re-agents used in this method are: 1. Dilute Sulphuric Acid. 2. Solution Nitrate Silver. 3. Solution Arsenious Acid. 4. Solution Iodine. 5. Bromine. 6. Solution Caustic Potassa. 7. Solution Pyrogallate Potassa, 8. Solution Sub-Chloride Copper in Hydrochloric Acid. 9. Lime Water. 10. Red Litmus Water. 11. Solution Acetate Lead.

In order to make an analysis of coal gas by this method, we must first make what is known as a qualitative analysis, that is, determine the presence of certain gases; this will decide the order of precedence in their removal.

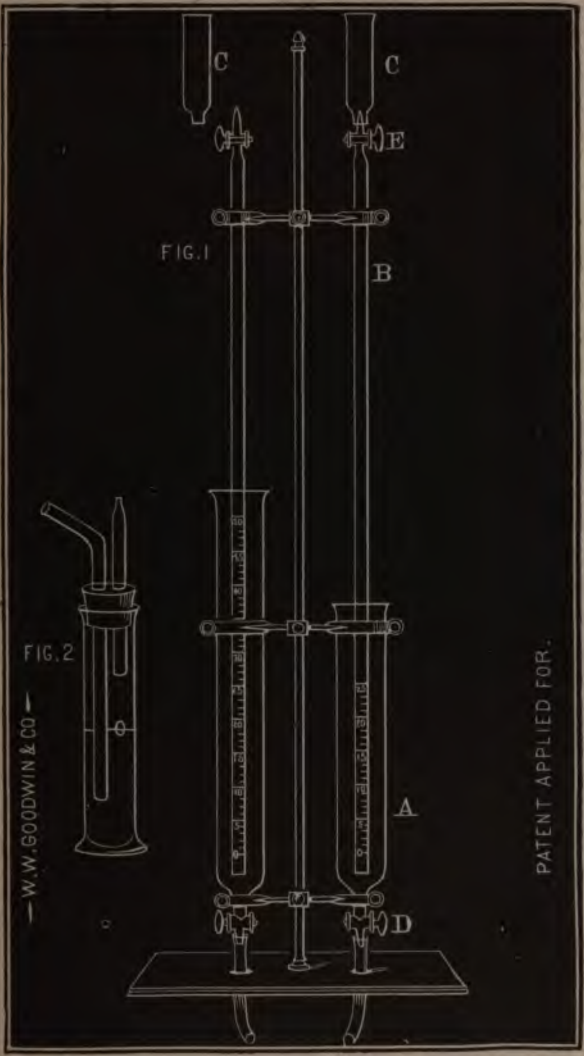
For this purpose we use apparatus No. 2, which is so constructed as to admit the gas to be bubbled through any liquid we may place in it. Thus if the gas is suspected to contain ammonia, (NH_3) we fill the apparatus (to say the O line,) with a solution of red litmus, and allow the gas to pass through the liquid for several minutes; if ammonia (NH_3) be present, the red litmus will turn blue.

If carbonic acid (CO_2) be suspected, we fill to O line the same apparatus (after washing,) with lime water, then pass the gas; if a white precipitate is formed, carbonic acid (CO_2) is present.

For detecting sulphuretted hydrogen (SH_2), we carefully cleanse the apparatus, and fill to the O line with a solution of açetate of lead; now pass the gas. If in a short time the liquid turns brown or black, the presence of this gas (SH_2) is shown. Carbonic acid (CO_2) will give with this solution a white precipitate, but if sulphuretted hydrogen (SH_2) be present also, the white will turn brown or black.

Having determined the presence or absence of these gases, we are now ready to use the second apparatus for determining the per cent of these and other gases.

Place the apparatus Fig. 1, as shown in drawing, fill the funnel A with water that has been standing in the room until it



has acquired the same temperature; we now adjust a flexible tube upon the tip of Eudiometer B, open the stop-cock E,

and by exhaustion fill the tube with water from the funnel A; when full, close stop-cock E, and remove flexible tube, which is now placed upon a jet and the gas to be examined is allowed to pass through it for a minute or two. While it is thus passing freely we place it on the tip of the Eudiometer; by opening the stop-cock E the water will flow out and the gas will take its place. By opening the stop-cock D of funnel A the water will be drawn off until the gas fills the tube to the O point, when the stop-cock D of funnel A, also the stop-cock E of tube B are closed.

Now place the funnel C upon the tip, which completes the first part of the operation.

If in our qualitative examination we have found ammonia (NH_3) and sulphuretted hydrogen, (SH_2) we proceed to determine the per cent. of ammonia (NH_3). For that purpose we introduce about half-ounce of *dilute* sulphuric acid in the funnel C and gradually open the stop-cock E and allow it to flow down the tube, always leaving a little of the liquid in the funnel to prevent the introduction of air. A few minutes will be required for the liquid to subside, and the rise of the water in the tube will indicate the per cent., when we have drawn off the water in funnel A to the same level as the liquid in the tube B; this must always be done at each reading of the different gases.

It is also well to place in funnel C a little pure water to cleanse it after each reagent.

A better solvent for ammonia (NH_3) is a solution of nitrate of silver mixed with a solution of arsenious acid in equal quantities; this cannot be used if sulphuretted hydrogen (SH_2) be present.

For sulphuretted hydrogen (SH_2) we place in the funnel C a solution of arsenious acid, and allow it to flow down, the rise of the water in the tube will indicate the per cent. of this gas. (SH_2)

When we find ammonia (NH_3) we do not find carbonic acid (CO_2) and *vice versa*. So if our qualitative examination shows carbonic acid (CO_2) we commence our quantitative analysis for this gas instead of for ammonia (NH_3). Its well-known sol-

vent is a dilute solution of caustic potassa; about one-half oz. will be sufficient to place in the funnel C ; when passed down the tube it causes a rapid absorption, and the rise of water shows the per cent.

For bi-sulphide of carbon (CS_2) one-half ounce of solution of iodine in water is placed in funnel C and carefully allowed to flow down. The rise of water gives the per cent. (CS_2).

We next absorb the illuminating gases, which, in all probabilities, will be a mixture of olefiant gas (C_2H_4), acetylene (C_2H_2), per carbide of hydrogen, and the vapor of benzole. These are all acted upon and dissolved by bromine ; to use this very heavy liquid, we first place in funnel C one-half ounce of water, and for coal gas, two or three drops of bromine (for naphtha gas, ten to fifteen will be required) and very carefully allow the bromine to flow down. It will fill the tube with a red vapor, if we have added enough, and will cause an expansion of the gas in the tube instead of contraction. After a few minutes we place in funnel C one-half ounce of solution of caustic potassa with the vapor already there, and allow it to flow down ; this will absorb the red vapor, and the rise of water in the tube will give the per cent. of illuminants.

For air, use one-half ounce of pyrogallate of potassa, and wash down with water ; the rise will give per cent. of oxygen, (O) and as oxygen is one-fifth of the air, we say four times the per cent. observed is nitrogen (N) or five times the per cent. observed is air, and so record it.

For carbonic oxide (CO), use half an ounce sub-chloride copper in hydrochloric acid ; this absorbs this gas, but before reading the per cent. wash with water, and after the water a little caustic potassa is allowed to flow down ; the rise of the water gives the per cent.

The remaining gas in the tube is a mixture of hydrogen (H) and light carburetted hydrogen (CH_4) plus the nitrogen (N), and will be so recorded. It is seldom necessary to make separation of these gases, for they both serve to dilute and carry the illuminating gases. In coal gas they are about equal in quantity.

This completes our analysis, and if the temperature of the room and all the re-agents used have been the same, and we have been careful not to handle the tube with our warm hands, the readings will be approximately correct.

It is well to have a second tube, as shown, filled the same as the one we use, to note any change of temperature.

It is important that the order here recorded be carefully observed.

Capt. White—I move that the thanks of the Association be tendered to Mr. Goodwin for the explanation of his apparatus. Carried.

Mr. Cartwright—Mr. President: I now propose the name of Mr. William King, of Liverpool, as an honorary member of this Association.

The President—Gentlemen: I have no doubt that if there was time you would wish to speak upon this subject. Mr. King visited this country recently, and a description of his reception in New York is given in the *Gas Light Journal*. The limited time at our command prevents my speaking of his merits as they deserve.

The Secretary—The Executive Committee have had in consideration the subject of recommending Mr. King as an honorary member, and they now nominate him as such.

The President—I have received notice from the Executive Committee that they have proposed the name of Mr. William King, of Liverpool, as an honorary member of this Association, and it is moved and seconded that the Secretary be authorized to cast the ballot of the Association to that effect.

The motion was carried, and the President appointed Mr. White as teller to receive the ballot, who announced the unanimous vote of the Association in favor of the election of Mr. King.

Upon motion, Mr. Slater was asked to explain a diagram showing the consumption of gas by his company since its organization, which he did.

Upon motion of Mr. Denniston, a vote of thanks was tendered to Mr. Slater for his explanation.

Upon motion of Mr. McIlhenny the Convention then adjourned *sine die*.

SIXTH ANNUAL MEETING

OF THE

AMERICAN GAS LIGHT ASSOCIATION,

Held at the Fifth Avenue Hotel, New York, October 16, 1878.

The Association was called to order by the President, Gen. Roome.

On motion of Mr. Neal, the reading of the minutes of the last meeting was dispensed with.

The following applications for membership were presented:

E. V. WHITE, Portsmouth, Va.

F. A. STACEY, Cincinnati, O.

M. S. GREENOUGH, Boston, Mass.

A. H. BARRET, Louisville, Ky.

C. F. SPAULDING, Brookline, Mass.

H. A. ALLYN, Cambridge, Mass.

T. O'C. SLOANE, Ph. D., Brooklyn, N. Y.

G. D. BILL, Malden, Mass.

On motion of Mr. Cartwright the secretary was authorized to cast a ballot for the Association, in the usual form. The President appointed Mr. Cartwright and Mr. Cornell to act as tellers, and the gentlemen named were declared duly elected active members of the Association.

THE PRESIDENT (the new members being presented) said—Gentlemen:—It gives me very great pleasure to receive you among us, to participate with us in our deliberations, to assist us in obtaining that knowledge which is for the benefit of mankind at large, to advance the interests of the companies we represent, and to promote each others happiness and welfare.

I have only to say, further, to these new members, that, pleased as we are to welcome them, the secretary will be still better pleased to get $10 apiece from them, and they will please step up to the secretary's desk and settle. [Laughter.]

THE PRESIDENT then addressed the Association as follows:

PRESIDENT'S ADDRESS.

Gentlemen of the American Gas Light Association:—We again have the pleasure of meeting together to consider matters connected with the vast interests committed to our supervision, and I trust I do but echo the general sentiment, when I express the great pleasure it affords me to greet you once more, and to be able to say to you that our progress during the year has been in the highest degree satisfactory.

As I have had the honor of saying to you on former occasions, we move only in accordance with the fixed laws of science, which we cannot alter if we would, but which we may reasonably confess, have not been entirely revealed to us, for we know that what we have accepted in the past as absolute truth, has, in the course of study and investigation been demonstrated to be otherwise; hence, we see that it still remains for us to wrest from the hitherto unknown whatever may appear calculated to lead us in the path toward perfection.

Permit me to suggest, that although many of us have given the best years of our lives and the most earnest devotion of which we have been and are capable, to the advancement of our profession, still we are none of us masters, in the sense that there is nothing for us to learn, but only students, willing to sit at the feet of any one who can teach, and from whose experience we may learn. Let me say, too, that we come here, not with any selfish motives, not for individual advancement, or the acquisition of personal fame, but only and always that, placing the fruits of our individual study and application upon the common altar, we may cull therefrom the choicest flowers, and in our own homes and laboratories draw from them the incitement to future and better progress. Whatever we may gain is not for ourselves—for we must pass away and be fogotten—but for the interests of

the people and the credit of the nation. On the principle that he who makes two blades of grass grow where only one grew before is a national benefactor, so it is that in our profession, as, indeed, in any other, he who by his study and devotion contributes to the comfort and convenience of the people, confers a national benefit. So again, we Americans, by which I mean we who people this North American Continent, young still in the world's history, are competing with the old world, and, whenever we can surpass its denizens in the arts and sciences, we have double cause for rejoicing, not only that we have added to our own national fame, but that we have contributed our share to the advancement of intelligence on those distant shores from which, in the natural order of things, we might expect to receive rather than to impart instruction.

I greet you again, then, gentlemen, as the appointed representatives of a business interest, which involves the very highest sanctions of science, and the best convenience of the people.

It is one of the most common topics of newspaper criticism to ascribe to our profession a desire to accumulate gain without regard to the means leading to it, and yet, in your behalf, I venture to say that there is no business where there is a greater desire to afford the product of industry at a closer remuneration than this, and none, where those in whose behalf such business is carried on, are more disposed to believe all that is said by persons inimical to us and our industry. Out of the labors of this Association there ought to grow—nay, there is growing—a different appreciation, and I look forward with confidence to the time when our labors will be recognized and accepted as one of the agencies tending to the elevation of our national character, and giving us a rank not to be outshone by the labors and discoveries of Europe, hoary with the dust of centuries.

We are here, gentlemen, to consider what has been accomplished during the year now drawing to its close, and to unite in counsel for the history we are to make in the future. Let us not forget that whatever we may have achieved is simply a stepping-stone to further and more important advances. Sir Isaac

Newton, when complimented upon his discoveries in science, said, "I am like a man standing upon the sea-shore; it has been permitted me to pick up here and there a few pebbles, but I cannot forget that there is a whole ocean before me." And Daniel Webster once remarked, "We wonder at startling discoveries made from time to time, but we go on from age to age, and find this earth a constant study, affording delight and rewarding our every effort."

Such is our chosen mission; we have voluntarily made ourselves the apostles of study and devotion, and while we are in the discharge of our duties as such, there can be nothing too simple nor yet to recondite for our examination. Let, then, the most modest among you, who imagines that he has discovered some principle or process hitherto concealed, frankly explain it here among his peers, and let us all approach its discussion in the spirit that becomes earnest, serious men, and so out of our deliberations will come that which we seek, and for which this Association was organized—"the greatest good of the greatest number."

It may, perhaps, be expected that I should refer in this brief address to various matters that have been presented to me during the recess. I am free to say that many such have received my careful attention and earnest consideration, but I do not feel at liberty to forestall your opinions, even constructively, by expressing my own at this time. It is rather to be desired, as the words already spoken will demonstrate to you, that each should examine for himself the matters that may be presented, and out of our mutual counsel there will grow at least an approximation of the truth. By such communion we shall separate with the impression of friendly counsel, and, I doubt not, the conviction that the world is not yet ready to dispense with gas light.

The address was greeted with continued applause.

REPORTS OF COMMITTEES.

MR. DENNISTON, Chairman of the Executive Committee, made the following report:

To the Officers and Members of the American Gas Light Asso-

ciation :—The Executive Committee offer the following report and recommendations :

1st. That the following papers be read—

By CAPT. G. W. DRESSER, of New York, upon the Gas Works of London.

By. J. S. CHAMBERS, of New Jersey—Facts in regard to Water Gas, etc.

By CHAS. H. NETTLETON, of Derby Conn., on Selling Gas.

By G. A. McILHENNY, of Washington, D. C.—Government of Gas Works.

By T. O'CONNOR SLOANE, of Brooklyn—Relations of Light and Heat in Gas Flame.

2d. We further recommend that the salary of the Secretary and Treasurer be fixed at $250 for the ensuing year.

3d. That the surplus funds in the treasury after each annual session be safely invested by the treasurer, with the approval of the Finance Committee.

4th. That the printing, in book form, of the proceedings of the Association be deferred until after the next annual meeting.

5th. That the distribution to new members of the printed reports be confined to the date of their admission.

6th. That sales of copies of the printed reports to non-members may be made at the rate of $1.50 per volume.

7th. That the President, Secretary and Chairman of the Executive Committee, be a Committee on Lectures.

8th. We recommend for honorary membership W. W. Greenough, Esq., of Boston.

W. H. DENNISTON,
Chairman.

MR. DENNISTON—These recommendations have been considered by the committee, for reasons given by the secretary and others, and they have been made in this form. I, therefore, move that the report be received, and that the recommendations be acted upon singly; there are some that may cause

considerable discussion. Carried. It is necessary that some of these recommendations should be acted upon before the election of officers takes place.

The President—In the regular order of business, as prescribed by the By-laws, the reading of papers comes last. I suppose the recommendations of the committee, referring to the business that, in the order prescribed by the By-laws, is to come before us, are first in order.

Mr. Coggshall—I submit the question of the propriety of those recommendations coming before the association under the head of general business. We generally receive these reports in the general order of business, and lay them on the table until the proper time for taking action upon them arrives.

Mr. Denniston—As I said before, it is necessary that some of these recommendations should be acted upon before the election of officers takes place.

Mr. Coggshall—Does not action upon the recommendations of this report come under the head of general business?

The President—The reading of papers, according to our By-laws, comes before "general business."

Mr. Denniston—I think the Association will see that it is necessary to act upon some of these recommendations before the transaction of "general business" is reached.

Mr. Neal—I move that action be taken at once upon the resolution of the committee, in regard to the election of Mr. Greenough. Carried.

The resolution was then unanimously adopted.

The President—It gives me great pleasure to present to you, for election as honorary member, Mr. W. W. Greenough, of Boston, formerly president of the New England Association. He is a gentleman I have known for many years; a high-toned and accomplished man, and deeply attached to the profession in which we all take so much pride. They have done me the honor to make me an honorary member of that Association, simply, I presume, because of the distinction you have conferred upon me here. So far as that is concerned, I feel highly

complimented in being made an honorary member of that Association, which is working for the same purpose as our own. But, apart from that, the individual merit of this distinguished gentleman is of such a high character, that it will be an honor to receive him among us. I, therefore, propose that we now proceed to elect this gentleman as an honorary member.

On motion, the secretary was directed to cast a ballot of the Association. Mr. Cartwright and Mr. Cornell were appointed tellers, and declared Mr. Greenough unanimously elected an honorary member.

MR. M. S. GREENOUGH—Permit me, gentlemen of the Association, to express, on behalf of my father, his appreciation and my own, of the kind words your President has uttered, and to thank you for the honor you have conferred upon him in making him an honorary member of this Association.

THE PRESIDENT—It will be in order now, I suppose, to take up the report of the Executive Committee, in reference to the recommendation about reading the papers. Do the Association wish to vote upon that?

On motion, the recommendation was adopted.

THE PRESIDENT—The committee desire that we should take separate action on each one of them, and they prefer that it should be done at this time, and I see no objection to it.

MR. HARBISON—I move the adoption of the second recommendation of the Executive Committee, that the "salary of the secretary and treasurer of the Association be fixed at the rate of $250 per annum."

MR. DENNISTON—I beg leave to say, in regard to this recommendation, that it was made after careful consideration of the amount of funds in the hands of the Association, and its requirements. We thought it advisable, among other things, to reduce the salary of the secretary. There was no intention to reflect in any way upon the present efficient officer. He has given entire satisfaction, I believe, and it was not on that account that the salary was reduced, but in the hope that the duties of the secretary in the future would be lighter than they have been in the past, and $250 was deemed sufficient by a

majority of the committee. There are other members of the Association who would be willing to take it for that amount, and we hoped that the present secretary would retain the position.

MR. NETTLETON—I wish to say that, knowing what the duties of the secretary have been for the last three years, I shall respectfully decline the office if the salary is reduced to those figures. I do not say this to influence the action of the Association in any way, but only because the duties are too numerous, and require too much time to be performed for that sum.

MR. SPAULDING—From year to year this Association, like others of the same kind, is increasing in number, and I should think it would be better to let the salary remain as it is at present, instead of reducing it to $250, as proposed; and I move that, as an amendment to the recommendation of the committee.

MR. HARBISON—When the salary was fixed, three years ago, at $250, it was said that the labors of the previous year had been more than usual, and the Association was not then in the possession of a large amount of funds. Two hundred and fifty dollars was paid for services for the previous year, that being all that the committee believed they could afford to pay, or ought to pay. It was also voted that, for the year following, the sum of $250 should be paid to the secretary and treasurer; so that, at that time, the amount of $250 was voted for the year preceding, and the year following, as an equivalent for the services that had been rendered. It was then understood, by a majority of the Executive Committee, that it would not be necessary to pay $250 for the years to come—we having voted, as it was then understood, to make up what we could not afford to pay the year before. Last year, at Cincinnati, it was raised to $350. For one, I think that amount is larger than the Association is able to pay. I think the $250 is sufficient for the duties to be performed; and, if the duties of our present efficient secretary will not warrant him in accepting the position, there are other members who can perform the duties, and are willing to do it. I do not think, therefore, that we ought to

pay this large amount, when other members of the Association are willing to do it for less.

The Executive Committee were unanimous in their recommendation to reduce it to $250.

MR. SPAULDING—I would like to inquire how much money we have in the treasury, in order to see whether we can afford to pay it or not?

MR. NETTLETON—The balance yesterday morning was $624.00.

THE PRESIDENT—I suppose the Finance Committee can give us such information as may be required to answer that question, without reading the whole report. All we need is a sufficient statement to guide our action at present.

MR. DENNISTON.—The total sum that we should have, after the collection of the dues that are now due, with the money on hand, would be $1,559.00. Out of that was taken what we considered the expenses would be for the year, provided another book containing the proceedings of the Association was printed. In that event, the expense would be, during the year, about $1,250, which would leave a balance, on hand at the close of next year, of $309.30, and then, if we add to that $625, which we thought would be the expense of printing the book, which, if we do not print, will be so much additional, then we shall have on hand in the neighborhood of $930 at the close of the next year.

MR. CABOT.—I would like to inquire at how much you estimated the secretary's salary.

MR. DENNISTON.—We put it down in the estimate at $350, the same as it has always been.

CAPT. DRESSER.—I presume there is no one connected with the Association who is more familiar with the amount of work that is done by the secretary of this Association than I am. It seems to be a very simple matter, but there is a great deal of little work, which takes much time. But, aside from the labor, it seems to me that an Association representing the whole of North America ought not to be here trying to reduce the salaries of their officers forty per cent., when, at the same time,

they are not able to put the price of gas down so much as that. I think Mr. Nettleton is entitled to the money that he receives, and it seems to me to be a small salary for the Association to pay. Besides that, according to the showing of the Finance Committee, even estimating the salary at what it now is, and not recommending the printing of any book, there seems to be plenty of money on hand. I do not see why the "laborer is not worthy of his hire, and why he should not be paid good wages. I hope the resolution reducing the salary of the secretary will not prevail.

MR. HARBISON.—A single word in reply: It is very well for Major Dresser to tell one side of the story, and talk about reducing the salary of officers forty per cent., and not reducing the price of gas, but he does not say that two years ago the salary of the secretary was increased eighty per cent., and the price of gas was not increased.

CAPT. DRESSER.—That was merely making the thing right. It had not been made right before, and it was simply doing justice.

MR. HARBISON.—It does not seem to me advisable that all the money that is received for admission should be paid out for salaries of officers and for the printing of reports which we get through the *Gas Light Journal.* One of the recommendations of the Executive Committee is, that there should be a committee appointed who would engage to procure persons to lecture upon scientific subjects before the Association, at the expense of the Association. In that way we shall get some information, and I think the money spent in that way will be of far more service to us, as a body, than if it is spent in paying salaries to officers, and for printing reports which we get through the *Journal.* I think it is highly important to our advancement that these lectures should be given by those who are qualified to instruct and enlighten us on subjects closely allied to our profession. Passing the publication of the book another year is simply passing over for a few months the printing in book form of what we will have in the *Journal* in any event. If published next year; the proceedings of this year and the next will make a good sized volume.

Mr. Cabot—I don't know that I ought to speak about what influenced the committee as a committee; but I suppose I have the right to speak about the considerations that had their weight with myself. What influenced me very much in voting for the reduction of the salary of the secretary was this. It seemed to me we had arrived at a point in our history when we should be doing a little more than merely meeting for discussion. We want gentlemen to give us lectures. We want to make some progress in our profession, and we want to avail ourselves of all the means we can command to aid us. We want those whose profession leads them to carefully study and investigate science which applies to our business, to give us the benefit of their views, and we want to pay them for it out of the funds of the Association. We do not want to be beggars, and there is no reason why we should be. Besides that, we want to collect statistics, and other information, for distribution among the members of the Association, which will require money. I think we ought to be putting our financial department in such a shape that we shall have a fund which we can, in the future, use in this way.

All these considerations prompted me to coincide with the recommendations of the Executive Committee. I do not pretend that $250 will pay the secretary for the services that he performs; but it is customary, in an Association of this kind, or, at least, it is so in many instances, for gentlemen to give their services without any pay. I feel, for one, that we should begin to reduce our expenses, and apply our money where it can be used more to the benefit of the Association at large than it has been. As to the publication of the book going over another year, as has already been stated, it was thought that the publication of our proceedings in the *Gas Light Journal*, would answer our purpose for the present year; and next year we can have the proceedings of this year and the next—the work of several years can be put in one volume and filed in our libraries. I hope the salary will be fixed at $250.

Mr. Spaulding—There seems to be various opinions in regard to the salary, and I would propose an amendment which, I think, will meet the views of all. I propose that the salary

be fixed at an even $300. That, as I should think, would be satisfactory to all parties.

Mr. Denniston—Members will please bear in mind that the salary they are now fixing is for the ensuing year. The secretary receives $350 for this year. The present officers will serve during the present session of the Association. If a reduction is made in the salary, it will apply to the next year, and not to the past year. That is one of the reasons why I asked that action be taken upon the report of the committee before the officers were elected, so that the persons who might be elected would have full notice of what the salary was for the coming year.

The President—The question now before the Association is upon the recommendation of the committee to fix the salary of the secretary at $250 per annum. An amendment has been made to that recommendation that it be $350 per annum. To that amendment another amendment has been offered, making the salary $300 instead of $350. The question now is on the amendment making the salary $300 instead of $350.

[A rising vote was taken. Affirmative, 39; negative, 19.]

The President—The question now is on the passage of the resolution, as amended, viz., that the salary of the secretary be fixed at $300 per annum. Carried.

The President—The next question is the adoption of the third resolution embodied in the report of the committee, to wit: "that the surplus funds in the treasury, after each annual session, be safely invested by the treasurer, with the approval of the Finance Committee."

Gen. Hickenlooper—I move that the resolution be amended by inserting the words "United States Government Bonds." I think it would be proper to indicate the manner in which the funds should be invested, and there is certainly no more secure investment than government bonds.

Capt. W. H. White—Without discussing at all the relative merits of different forms of investment, and without questioning the security of government bonds, it is proper for me to call attention to the fact that it would be very inconvenient and unsatisfactory to sell these bonds whenever we wanted to

obtain money for the uses of the Association. It seems to me it would be better to invest the funds in some well-known and sound safe-deposit company or savings bank, where it would draw a reasonable interest, and where it would be subject to the drafts of the proper officer.

GEN. HICKENLOOPER—If there is any better security than United States Government Bonds, I do not know what it is; and you can sell the bonds and realize upon them with the same facility that you could use your money were it in a bank or safe-deposit company. Any fluctuation in the market value of the bonds, is as liable to be in favor of the Association as against it.

CAPT. WHITE—Without entering into a discussion of the question at all, I would simply state, that it is very inconvenient to be obliged to sell a $1,000 bond when it is necessary to use $250 or $300, besides losing the interest on the money; whereas, if you draw $250 from the bank, you will not lose the interest on the part that remains on deposit.

GEN. HICKENLOOPER—Perhaps it has not occurred to my friend Capt. White, that there are $100 government bonds, as well as $1,000 bonds.

MR. HARBISON—Before the question is put, I would suggest to the Association, whether there are not other bonds in which our funds can be invested, as secure as government bonds, and which pay a higher rate of interest. I think there are. At any rate, I believe the gentlemen of the Finance Committee are capable of deciding what form of investment they had better make. If the money is intrusted to them at all, it seems to me that we ought to trust them with the duty of safely investing it. I don't think the committee ought to be instructed as to what investment they ought to make, but I think the matter ought to be left to their own judgment and discretion.

THE PRESIDENT—As the recommendation of thec ommittee now reads, it is left to the discretion of the treasurer, with the approval of the Finance Committee, to safely invest the funds. If this amendment is adopted, instructing the treasurer and Finance Committee to invest in United States bonds, it simply

leaves them to decide what government bonds. As it now stands, the treasurer cannot invest in government bonds, or anything else, without the approval of the committee. But now, if this amendment is adopted, the Finance Committee would be restricted to investment in government bonds alone.

A MEMBER—I move that the whole matter be left to the Finance Committee.

THE PRESIDENT—I shall declare that motion out of order, because if you vote adversely upon the amendment proposed, the effect will be to leave it in the hands of the Finance Committee. The question is on the amendment offered by Gen. Hickenlooper, that the committee be instructed to invest the money in United States Government Bonds.

The amendment was lost.

THE PRESIDENT—The question now recurs upon the original recommendation of the committee, that the surplus funds in the treasury after each annual session be safely invested by the treasurer, with the approval of the Finance Committee. Carried.

THE PRESIDENT—The next question is upon the adoption of the fourth recommendation, that the printing in book form of the proceedings of the Association be deferred until after the next annual meeting. Carried.

THE PRESIDENT—The next question is upon the fifth recommendation of the committee, that the distribution of printed books to new members be confined to the date of their admission. Carried.

THE PRESIDENT—The next question is upon the adoption of the next recommendation of the committee, viz.: that the sale of copies of the proceedings of the Association, to parties not members, may be made at the rate of $1.50 per volume.

CAPTAIN DRESSER—Before that recommendation is acted upon, I would like to say a word in regard to it. It seems to me that the price of these proceedings, as printed in book form, ought to be at least equal to the fee for annual membership. If a man does not take the trouble to come here, and will not pay for his admission as a member, I do not think he ought to get

ıll the advantages of this Association for $1.50, and I think he :ertainly ought to have to pay for the printed volume a price ıt least equal to the amount of annual dues.

MR. HARBISON—I object to the suggestion made by Capt. Dresser that those who are not members should be obliged to pay $5 apiece for these reports. I do not think this Association wants to go into the book business, and get 25 per cent. profit on what they sell. Besides that, any one can obtain the *Gas Light Journal*, in which these proceedings are printed. The committee were of the opinion that $1.50 was sufficient, and that 38 or 40 cents would be sufficient profit to make, the books costing $1.10 to $1.12.

THE PRESIDENT—The question is on the amendment offered by Capt. Dresser, that the amount to be charged for these volumes, to non-members, should be equal to the yearly dues.

The amendment was lost.

THE PRESIDENT—The question now recurs upon the original recommendation of the committee, that the price be $1.50 per volume. Carried.

THE PRESIDENT—The question now is upon the adoption of the seventh recommendation, which you have heard, regarding lectures. Carried.

The report as a whole was then adopted.

TREASURER'S REPORT.

MR. NETTLETON—I have here the report of the Treasurer, but for the present purpose I suppose a synopsis is all that will be required:

Balance cash on hand from last year,	$169 32
Cash received from initiation fees,	160 00
Cash received for annual dues,	735 00
Four copies proceedings sold (3 vol. I., and 1 copy vol. II.) and old paper,	6 17
	$1,070 49

CASH PAID.

For 100 copies vol. II., ...	$47 06
For salary of secretary and treasurer, .	350 00
For printing, ...	6 15
For insurance on books, Vol. II, proceedings	4 25
Postage, postal cards, etc	38 43
	$445 89
Balance on hand . . .	624 60

Number of active members on roll, ...	188
Membership payment commuted, ...	1
Honorary members, ...	3

In reference to the amount paid for printing extra copies of the proceedings, I ought, perhaps, to say that when the volume was ordered to be printed, 500 copies was the number ordered, but 600 copies were printed, and it came about in this way: After having the 500 copies printed, the number I had on hand ran so low that I thought the Association ought to have more, so I asked those who had printed them what they would print 100 additional copies for, and they said $47.06, and I ordered the 100 copies to be printed, which I paid for myself. Then, when the meeting was held at Cincinnati, I stated the facts to the Association, and they authorized the purchase. That 100 copies cost $47.06, while the other 500 copies cost a little over $1 a copy.

On motion, the report was accepted, and entered upon the minutes.

REPORT OF THE FINANCE COMMITTEE.

MR. CHAMBERS—I am instructed by the Finance Committee to report that they have examined the accounts of the treasurer of this Association, and found the same correct, and that there is a balance in his hands of $624.60. This report is signed by all the members of the Finance Committee. On motion, the report was accepted.

REPORTS OF SPECIAL COMMITTEES.

MR. NEAL—There was a committee on statistics appointed, and Mr. McIlhenny was appointed chairman. I hope he has a report to make.

Mr. McIlhenny—Mr. President; I have no report to make, except a verbal one. After the adjournment of the Association last year, I corresponded with my two associates on the committee, in regard to getting up statistics, and sending a list of what I supposed to be the proper questions to ask the companies, and got their views on the subject, which concurred, with a slight difference, with my own. After thinking the matter over, and after corresponding with some of the companies, I come to the conclusion that it would be impossible to get the principal companies of the country to submit their statistics for publicity; and, consequently, dropped the whole matter. I did not suppose there was a gas company in this city that would furnish this Association with its statistics, and I did not think it would be worth anything unless it was universal. For these reasons I did not pursue the matter any further, but dropped it. That is the only report I have to make on the subject.

On motion, the report was accepted, and the committee discharged.

Mr. Neal—I understand there was a committee appointed to prepare a paper giving the Association the benefit of their investigation in regard to the subject of unaccounted-for gas. I think Mr. Dwight is one of the members of that committee.

Mr. Dwight—This is all news to me. I think there must be some mistake.

Mr. Neal—On page 246 of the report of last year, I find that such a committee was appointed.

The President—I was not aware before that I was on that committee.

On motion of Mr. Clement White, the committee was discharged.

ELECTION OF OFFICERS.

On motion of Mr. Harbison, the following named gentlemen were appointed a committee by the Chair, to report a list of officers for the ensuing year:

J. P. Harbison,	G. A. McIlhenny,
C. E. Cushing,	A. C. Wood,
A. B. Slater.	

On motion of Mr. Spaulding, the committee was instructed to retire and report immediately.

A recess of fifteen minutes was then taken.

On the re-assembling of the Association the names of the following gentlemen were presented as applicants for membership:

J. D. MERRIMAN, Pictou, Nova Scotia.
JOHN KERR, Kingston, Ont.
CHAS. LEVER, Flushing, N. Y.

On motion, the secretary was instructed to cast the ballot of the Association in the usual form. Mr. Cornell and Mr. Cartwright were appointed tellers. The secretary cast the ballot, and the tellers reported the gentlemen named unanimously elected.

MR. DENNISTON—I ask leave to offer a resolution, fixing the hours of the meeting and adjournment of this Association, from ten until twelve, and from two until five o'clock; and providing that, on Thursday evening, the Association meets at Stevens Institute, Hoboken, N. J., at 7.30 o'clock, to listen to a lecture by Prof. Morton, of that Institution, upon the subject of electric light.

The resolution was adopted.

Upon question of Mr. Neal, Capt. Dresser gave directions as to the best method of going there.

MR. HARBISON—I would suggest that the Association meet here at an hour to be fixed, and that we go in a body; it will certainly be more appropriate than for the members to be straggling in, one at a time.

THE PRESIDENT—I would suggest that the members of the Association meet at the Stevens Institue, at 7.30 o'clock. It would be inconvenient for the members to go from here in a body, for the reason that they are not all stopping in this part of the city; and, besides, there would be some difficulty in securing the necessary street cars to convey them, as a body, to the ferry.

On motion, the suggestion of the president was adopted.

REPORT OF COMMITTEE TO NOMINATE OFFICERS.

MR. HARBISON—I am instructed by the committee to report the following list of names of officers for the ensuing year 1878–79:

List of officers for 1878–79.

President.

GEN. CHAS. ROOME, New York.

Vice-Presidents.

W. H. PRICE, Cleveland, O.
G. B. NEAL, Mass.
T. LITTLEHALES, Ontario.

Secretary and Treasurer.

W. H. WHITE, New York.

Finance Committee.

JNO. S. CHAMBERS, Trenton, N. J.
J. P. HARBISON, Hartford, Ct.
GEO. A. MCILHENNY, Washington, D. C.

Executive Committee.

W. H. DENNISTON, Pittsburgh, Penn.
GEO. D. CABOT, Lawrence, Mass.
G. A. HICKENLOOPER, Cincinnati, O.
HENRY CARTWRIGHT, Philadelphia, Pa.
F. C. SHERMAN, New Haven, Conn.
H. STACEY, Indianapolis, Ind.

I will say, in reference to the nomination for secretary, that when it was understood that Mr. Nettleton had declined to serve, the committee were unanimous in their recommendation of Capt. White for that position.

MR. NETTLETON—I said that I would not accept the position when it was proposed to reduce the salary to $250, but when it was put at $300 I cheerfully accepted.

On motion, the report was received.

On motion, the Secretary was instructed to cast the ballot of the Association for all the officers nominated, except Secretary —the vote for that officer to be taken by ballot by the Association. Mr. Cartwright and Mr. Cornell were appointed tellers.

The Secretary cast the ballot, and the tellers reported that all the gentlemen nominated were elected, except Secretary and Treasurer.

THE PRESIDENT—Gentlemen of the Association, I thank you very sincerely for this renewed expression of your confidence. I would gladly have had a younger man fill my place, had you so chosen. I am not getting too old to work, but I have a great deal to do. I am not able to devote that time to the interests of the Association that, as your presiding officer, is, perhaps, required of me. But as you have again honored me with your choice, and have called upon me again to assume the office of President, I shall, during the time at my command, do all in my power to advance the interests of the Association. Permit me, again, to return my sincere thanks for the kindness you have shown me. [Applause.]

On motion of Mr. Cabot, the Association proceeded to ballot for Secretary.

The President appointed Mr. Steel, of Buffalo, Mr. Wood, of Syracuse, and Mr. Battin, of Albany, as tellers.

MR. PRICE—That there may be entire freedom in this matter, I move that blanks be circulated among the members of this Association, and that they write thereon the name of the person for whom they vote. Carried.

An intermission of five minutes was taken to prepare the ballots.

MR. NEAL—I desire to state that a sub-committee of the Executive Committee have taken under consideration the propriety of procuring a larger hall in which to hold our sessions. This room, as you will observe, is already well-filled; and if, as is anticipated, there is a large increase in our numbers to-morrow, the room will not be sufficiently large to accommodate them. Captain White is looking around for a larger hall.

There is one, in the rear of this building, called "The Fifth Avenue Hall."

The room that we now occupy is a very pleasant one, but will not be so if many more arrive. The difficulty seems to be (in this city) that all the halls are too large. The people here have all large ideas. New York is a large place—almost as large as Boston—and the difficulty with the halls that we have heretofore held our meetings in is that they are too large. It is very pleasant and social to meet in a small room like this, but we are likely to suffer a good deal of discomfort if any considerable addition is made to our number. The hall in the rear of this building is a very pleasant one, and Capt. White is now negotiating for it, I understand, and I suppose he is absent on that mission. If the members can get along with the heated and crowded state of the room, I have no doubt we shall be more comfortably situated in a short time.

CAPT. WHITE—I desire to report on behalf of the committee appointed to ascertain whether it would not be advisable to secure a larger room, that we can obtain the Fifth Avenue Hall, adjoining this building, for $30 a day, entitling us to two sessions, with gas and all the attendance we need; and I should like to be instructed as to whether to accept or decline this offer from the agent.

A MEMBER—The desire has been heretofore to get a small room, and until this room is filled, I do not think it advisable to make a change.

MR. NEAL—The matter might be left in this shape, that if we found it was too uncomfortable, and too crowded, we could any time pass a resolution to adjourn to that hall.

On motion of Mr. Cornell, it was left to the discretion of the Committee as to whether future sessions should be held in the Fifth Avenue Hall or not.

Ballots having been prepared and distributed, they were collected by the tellers, and counted, and Charles Nettleton was found to be elected.

THE PRESIDENT—I announce that Mr. Nettleton has been elected Secretary of this Association. Do you accept the office?

Mr. Nettleton—I do; and return my sincere thanks to the members of the Association for my appointment.

A recess was then taken until 2 o'clock P. M.

AFTERNOON SESSION.

The Convention met at 2 o'clock, pursuant to adjournment, and was called to order by Mr. Price.

Mr. Price—Before General Roome left, this afternoon, he stated that it was possible he might not be able to get back, or might not be able to get back at the time fixed for assembling this afternoon. In either event, he wished me to go ahead, and wished me to fill his position, and take charge of your deliberations. Before going any further, I wish to give a notice which he requested me to give. He says that there is, at the works of his company, at the foot of Eighteenth street, a gas engine; and as many of the members have expressed a desire to see it, he invites you all to come and examine the engine for yourselves.

C. H. Nettleton—A gas engine has been brought here by Mr. Schleicher, and I would like to have the Association give the gentleman permission to explain it to us. He has taken some trouble, and been to considerable expense to bring it here. It is a matter of business, of course, but I think it would be no more than an act of courtesy on the part of the Association to recognize the trouble the gentleman has taken, and give him permission to exhibit it. He was here last night, and is a very pleasant and agreeable gentleman.

Mr. Price—I know of no objection.

Mr. C. White—I think our Constitution provides that a member may introduce any person he chooses.

Mr. Neal—The secretary is absent, and while he is away I would move that Major Dresser be appointed secretary *pro tem.* Motion carried.

Mr. Neal.—Before proceeding with the reading of papers, and while the members are assembling, I would like to call attention to the paper I have in my hand, called *The Plumber and Sanitary Engineer.* These copies are for gratuitous dis-

tribution, and I hope gentlemen will help themselves. A part of the paper is devoted to the subject of gas. The gas department is edited by Dr. Sloane, one of our members. It does not clash at all with the *American Gas Light Journal*; Major Dresser and the editor of this paper, I am informed, are on perfectly good terms. And you will see articles on the subject of gas here, and also something about electric lights.

MR. HARBISON—I will inquire whether the paper has been submitted to the Executive Committee and approved by them. [Laughter.]

CAPT. DRESSER then read a paper upon London Gas Works, as follows:

LONDON GAS WORKS.

In endeavoring to convey to you some idea of the Gas Works of London, it is not with a view of presenting anything especially new, or of making any comparisons between works there and here, that I have consented to prepare this paper.

The first point that I would impress upon your attention is the magnitude of the operations involved in lighting a great city; and secondly, the corresponding responsibility placed upon the shoulders of those to whom the management of these operations is intrusted; hoping the result of such impression would be to raise the standard of excellence which you, as engineers and managers may, set up for yourselves.

And here let me repeat what has been said to you before by our worthy President: "There is no more honorable profession than that of a gas engineer," and no branch of engineering requiring a wider range of acquirement, or more skill in the application of the fundamental principles upon which engineering science rests. And one of the first things that a little attention to the *personel* of the management of the London companies suggests is, that the gentlemen in charge of those vast works are men who have fitted themselves for their positions by close and continued application and study.

With many of these it was my good fortune to meet, and in every instance I was received with a whole-souled hospitality,

cordiality, and frankness that I must attribute much more to the relations that I sustain to you and your profession than to any personal worthiness of my own; and I am sure that the establishing of friendly relations between the gas managers of Great Britain and those of America will even be more than heartily seconded by our English cousins. And some of us may see the day, I trust, when a joint meeting of the British Association of Gas Managers and the American Gas Light Association may be held in the city of New York, in October of the year eighteen hundred and ——.

The population of London is not far from five million, and there was distributed (gas sold) among this number of people during the year 1877, by the principal companies, fifteen thousand one hundred and eighty-five millions of cubic feet of coal gas (15,185,000,000).

There was manufactured, 16,364,000,000 cubic feet.

The amount of coal carbonized was 1,614,246 tons, of which 5 per cent. was cannel.

[If a man counts 100 every minute, and counts 10 hours a day, it would take him nearly 17 days to count one million.]

The price of gas sold varies from 3s. 2d. to 4s. 4d.; but the average price is about 3s. 6d. (87½ cents) per thousand feet.

London is at present lighted by the following companies:

1. The Gas Light and Coke Company (commonly known as the "Chartered," with which, at various times, the following companies have been amalgamated, viz.: the Imperial and Independent, the City of London, the Great Central, the Equitable and the Western.) formed 1810
2. The Phœnix Company, " 1816
3. The South Metropolitan, " 1833
4. The London Company, " 1833
5. The Commercial, " 1847
6. The Surrey Consumers Co., " 1854
7. The Crystal Pal. Dist. Co., " 1854
8. The Lea Bridge " " 1868
9. The West Ham Company " 1846

Of these, the first six are known as the Metropolitan Companies, the three latter being situated in what was but a few years since the suburbs, although now they are no longer so, but are simply in the outer portions of London.

It may not be inappropriate here, to say a few words upon the government of London. "The City," so-called, comprises but a small portion of London, situated near its centre. It is only over this small portion that the Lord Mayor presides. There is no one general government having control of the whole, but the different portions are governed by "vestries," which are elected by the people of the district comprised within the various limits by which the different parishes are bounded. These districts were undoubtedly once church parishes simply, and the vestries had the government under their charge. The paving of the streets and the lighting of the same are now under their control so far as making contracts are concerned.

The Metropolitan Board of Works is composed of members elected by the vestries, and was created by act of parliament, to have the general charge of certain public works where a unity of action was necessary that could not be obtained by any attempt at co-operation between the vestries of the different parishes—as, for instance, the construction of the general sewers of London, the construction of the Thames embankment, and works of such general nature. The Metropolitan Police is also established by act of parliament, and is under a board having general jurisdiction. There is also another board, known as the Board of Trade, and it is under their jurisdiction that the gas referees act.

Of the Metropolitan Gas Light Companies named, the Gas Light and Coke Company, and the Commercial, are on the north side of the Thames. The Surrey Consumers, the South Metropolitan, and the Phœnix, are on the south side, while the London Company, having the principal portion of its district on the south side, still has a portion on the north.

Of the Gas Light and Coke Company, or, as it is commonly called, the "Chartered Company," it is the largest, as it has been gradually increased by amalgamation with other companies. The wisdom of this course is too evident to all gas

managers to require comment, and results obtained in the practical working are the most positive proofs of the advantages to be derived by both consumers and shareholders, by reducing the number of companies and bringing the operations under the guidance of a single direction.

Efforts are now being made to secure still further amalgamation, by uniting to the Chartered Company the Surrey Consumers, the South Metropolitan, and the Phœnix. Should this be brought about, as it doubtless will be in time, the further union of this company with the remaining ones would doubtless follow ; and, under the legislative control to which they are subject, it would appear that the sooner London can be lighted by *one* company, the better it will be for all concerned, and the cheaper will be the price of gas to the consumer. The whole system of organization and accountability is very different from ours. If a company desires to raise additional capital, for the purpose of extending its works, a bill must be presented to Parliament, setting forth what is required, and the matter is considered by a committee to whom the reasonableness of the sum asked to be authorized must be shown ; and when granted, of late years, it has been done under certain regulations as to disposing of the additional stock by auction, under what is known as the "auction clauses," and also restrictions as to dividends, by which, when the amount of earnings exceed a certain per centage, the price of gas must be reduced. The result is that no more stock is issued than is expended in works, and the return upon the investment is made reasonably sure, inasmuch as certain reserve funds are allowed, from which deficiency in the dividends may be made up, in case that, from some unforseen reason, the profits of the year are insufficient.

Published accounts are required in certain prescribed forms, from which the operations of the year are made known. There is no question that the publishing of the accounts does much to remove many false impressions and much mystery about the supposed fabulous profits of the gas companies.

The amount of capital authorized for the six metropolitan companies is $77,815,890, while of this sum $59,200,000 is actually raised. Of this amount the Gas Light and Coke Company have $40,000,000 raised.

It is difficult to convey an accurate idea of the business of this company. They have some ten stations in different parts of London, on the north side of the river. Of these the famous works at Beckton are the largest, where last winter they sent out twenty millions of cubic feet of gas in a day. These works are practically six works placed together. They are situated on the river, below London, on ground belonging to the company of some four or five hundred acres in extent. All the equipments of these works involve the application of the most recent improvements in steam and hydraulic machinery.

A large pier is constructed in the river parallel to the banks, connected with the shore and the works by a viaduct carrying several railroad tracks. Large steamers come alongside this pier and are discharged with great rapidity by means of steam hoists placed below the deck of the pier, into trains of cars, which convey the coal directly to the retort houses. A complete network of railroad tracks enables every part of the works to be reached, both on high and low level, by steam cars. Some 15 locomotives are owned and used here by the company.

The retort houses are arranged with coal stores on each side, from which the coal is shoveled directly into the retorts. Foulis' mechanical stroker is used for drawing and charging, in a portion of the works.

The settings are usually sixes. The retorts are D's and "throughs," made in three pieces, and joined in the setting. Coke cellars below receive the coke as it is drawn. They work with a seal, and use the self-sealing lid. The condensers, purifiers, etc. are in the open air. Very large works for the working up of tar and ammoniacal liquor were in progress of construction, the design being to convey the tar and liquor from the other stations to this point for manufacture.

The works, as designed, are not yet all built, but are being extended each year.

Two 48-inch mains convey the gas to London, and much of the gas made in the day time is thus carried to different holder stations in the city. The holders are about 1½ million capacity each, but only a portion of those contemplated are erected.

The capacity of the 48-inch mains is reached, and it is proposed to establish a pumping station about three miles from the works, to increase the flow, until such time as a 6-foot wrought-iron main may be laid.

At several of the other stations of the Chartered Company *very* large works may be found, sending out six, eight, nine millions a day. Some very large holders of two millions capacity, are in very successful operation; but when we compare the enormous business done, with that required of our works, the large holders are not so much out of proportion. One engineer told me that he had seen one of his holders, containing 1½ millions, emptied in 1½ hours.

At Fulham, and at St. Pancras stations, settings of tens of brick retorts are in use; some benches that had been in use for twelve years were still working and doing good service. The settings of tens, worked from a traveling stage, were necessitated by want of space; but I think, otherwise, were not found so economical as sixes or sevens. The Chartered Company last year carbonized, at all its stations, 1,051,323 tons of coal, made 10,728 millions feet, and sold 9,935 millions, or the make per ton was 10,205 cubic feet, and the sale 9,450 cubic feet.

Each of the different stations is under the direction of an engineer who resides at the works. This is the usual practice throughout England, although it is not always the case.

The next largest company, in amount of coal carbonized, and gas made, is the Phœnix, which last year carbonized 163,478 tons of coal, made 1,652 millions of gas and sold 1,539 millions.

The manager of this company is Mr. Corbet Woodall, the late President of the British Association of Gas Managers, and under his direction the largest holder in the world is being constructed. It is 213 feet in diameter, telescopic, two lifts of 44 feet each, and will hold 3,100,000 cubic feet. This company has three manufacturing and holder stations.

Time and space do not permit the giving of many details connected with these and other works; but I will mention the South Metropolitan as being remarkable for selling the cheap-

est gas in London, the price last year being 3s. 2d. equal 77 cents per M; the other companies sell at prices varying from 3s. 3d. to 4s. The more general price is 3s. 6d., or about 87 cents per M. The London Company has recently ~~been~~ introducing improvements in the handling of their coal. Heretofore, all the coal coming to the city was discharged from vessels into barges below the bridges, and then floated up with the tide to the point where wanted. The London Company have had some large steamers constructed, with "falling" smoke-stacks, etc., which pass up under the bridges to the company's dock, near the works, where they are unloaded by hydraulic cranes, and the coal run by rail into the works. The appearance of large steamers above the bridges was a novelty.

To give a general idea of the workings of the London companies, I propose to treat them as a whole, and from published reports I have taken certain statistics, and taken the *averages* of all the six metropolitan companies *for five years*. For general comparison with what you may be doing yourselves, this may answer quite well enough. In converting sterling into currency, for convenience of calculation I shall call the shillings 24 cents, and the penny 2 cents.

Item of Cost, etc., per 1,000 feet of Gas Sold, as shown by the Averages of all the Six Metropolitan Companies of London, for the past Five Years:

1. The amount of capital employed per 1,000 cubic feet of gas sold, was .	14s. 4d.=	$3·40
2. Price of gas per 1,000 cubic feet,	3s. 11½d.=	95·00 cents.
3. Cost of coal per 1,000 cubic feet of gas sold, ...	26·74d.=	53·48 cents.
4. Working expenses per 1,000 cubic feet of gas sold, which includes purification, salaries, carbonizing, wages, wear and tear, distribution, rent and taxes, management, law charges, bad debts, etc.,	18·18d.=	36.36 cents.
5. Residuals per 1,000 cubic feet of gas sold,	15·09d.=	30·18 cents.
6. Gas sold per ton of coal carbonized, . .		9,035 cu. ft.

7. Gas unaccounted for, per cent, on make (4 years), ...		7·07
8. Bad debts, per cent. on gas and meter rentals, ...		·52
9. Net proceeds of residuals, per cent. on cost of coal, ...		56·19
10. Profit on gas, per 1,000 cubic feet sold,	15·48d. =	30·96 cents.
11. Net profit per 1,000 cubic feet gas sold,	13·93d. =	27·86 cents.
12. Dividend (standard) per 1,000 cubic feet sold, ...	13·43d. =	26·86 cents.
Per cent. on capital, about, ...		7·8

Recapitulation

Cost of coal per 1,000 cubic feet of gas sold,	53·48 cents
Working expenses, ...	36·36 cents.
	89·94 cents.
Less residuals, ...	30·18 cents.
Cost of gas less residuals, ...	59·66 cents.

Price of Labor.

The average price of labor has been :

In London, 1878.		*In New York*, 1873–1878.	
Stokers	$1 32	Firemen, . . .	$3 12½
Laborers	0 96	Helpers, ...	2 54
Bricklayers . . .	1 44	Bricklayers, .	3 12½
Carpenters, ...	1 44	Carpenters, . .	3 46
Blacksmiths, . . .	1 32	Blacksmiths, .	3 37½
Fitters, ...	1 36		
Service layers, . . .	1 20		
Lamplighters, . . .	0 72		

Price of Coal.

Average cost of coal per ton in London, $53.48 \times 9{,}035$,		$4 83
Average cost in New York for five years	Cannel, .	11 63
	Caking, . .	6 54
	Province, .	5 16

From these figures (which are official) each one of you can calculate the relative cost of your own gas delivered, and that in London ; and, although I am not able to speak from actual knowledge in any one case, much less in a general way for a series of years, still I am under the impression that, when due allowance is made for difference in cost of coal and labor, and the difference in the receipts for residuals, it will be found that gas is made as cheaply (in proportion) here as in London. I may be wrong in this ; and, if so, I am ready to be corrected. These are points that we need carefully collated statistics upon, which, unfortunately, we have not got. I hope this Association may soon have sufficient confidence in itself to begin the collection of such data.

A few words as to what may be termed the Police and General Managent of the working parts of the system of gas making in London:

The general cleanliness of the works was fair, but in many cases much more attention seemed to have been paid to the appearance of the engine and exhauster room than to other parts of the works. At some of the stations these parts of the works were a perfect delight to look upon, and one felt loth to leave them, while justice compels me to admit that, at other works, these and every other part were in such an untidy condition as, I trust, would be seldom seen here—or if seen here at all, they should not be commended by any gas manager.

As to the purification in London, it is simply absurd. The manager has, in fact, very little time to do anything but watch his purification. The restrictions, in some cases as hard as 16 grs. S. in 100 cubic feet, are simply absurd. In lighting the gas through a house with our ordinary sulphur matches, more sulphur would be set free than from 100 feet of gas with twice this amount. When asked by the gentlemen there what our limit of S. was in this country, I simply replied, we light our gas with sulphur matches.

At the meeting of the British Association of Gas Managers, Mr. Thomas Wills, F. C. S., delivered a lecture on the products of combustion, and on the sulphur question he remarked as follows :

"With regard to the question of sulphur in gas; you remember we concluded a short time ago that the air of a room must be constantly changed, or we could not exist, and that the change must be going on several times each hour; the whole atmosphere must be changed generally more than three times in each hour. Now, supposing sulphur is burned into sulphurous acid, and that it exists for even a part of an hour as such in the air uncondensed, it will come under the ventilating effect, and will undergo removal just in the same way as the aqueous vapor or the carbonic acid present in the air. If one-half of the sulphur remains in a gaseous condition for only one hour, it will be entirely removed within that period. I believe most of the ordinary effects which are attributed to the presence of sulphur in coal gas, and the damage that it does, are quite easily accounted for by other things. I believe the constant drying and wetting, coupled with the elevation of temperature and the presence of carbonic acid—effects which result from all illuminating fuels alike—are quite competent to account for the greater amount of damage which is represented as being solely due to the presence of sulphur. If we regard the absolute quantity, the figures become exceedingly minute, even if you have 20 grains of sulphur in 100 feet of gas. Supposing it to exist in the form of bi-sulphide of carbon, here is such a quantity of bi-sulphide containing 20 grains of sulphur. The quantity in this little tube, about an inch of it, represents 20 grains of sulphur, or the amount which we may take as being present in 100 cubic feet of our London gas. Now I could, if I had time, burn the whole of this quantity at once, and you would have all the sulphurous acid from it discharge into the air, and that would represent the sulphurous acid from 100 cubic feet, but I believe it would be impossible for you to find out the sulphurous acid, although it is there. Undoubtedly it is there, but it is diluted to such an extent that you could not find it by any ordinary test.

"If 20 grains of sulphur burn, they form 40 grains of sulphurous acid; a cubic foot of sulphurous acid would weigh 1,184 grains. Now, the thirtieth part of a cubic foot of sulphurous acid is produced by 20 grains of sulphur, or the amount in 100 cubic feet of gas, and I may say that such a

quantity in this room, supposing the room to contain approximately 60,000 cubic feet, would be represented by the block I hold in my hand, about 3¾-inch cube, and which, if diffused through the entire room, would amount to about one-half part per million in volume, or about .000001 per cent. in weight.

"If a proper arrangement were adopted to carry off the products of combustion, there would be no more complaints of sulphurous acid, and I believe that proper care ought always to be taken that coal gas should not to be burnt, in anything like quantity, without such arrangements being adopted. If this were done, all danger from damage by sulphur, even if it existed in greater quantity than it does, would be at an end; but I expect it would be found, supposing you could find out how to take the whole of the sulphur out, the compliant of the damaging effects would continue for some time, just the same.

"I may say, with regard to the percentage, it has been found that in the Manchester atmosphere, over a range of four miles, the amount of sulphur present normally, in the air, would be equal to the quantity which would be formed in this room by the presence, in it, of this amount of sulphurous acid; consequently, the whole atmosphere of that town we should expect to be doing damage by sulphur. If we regard the amount of coal burnt in London, 8,000,000 tons per annum, and if we take that coal to contain 1 per cent. of sulphur, which is burnt —whether in the form in which you send it into houses in gas, or in furnaces, or in grates, it is burnt away in some way—and which is a low average, we shall have 80,000 tons of sulphur thrown into the air, in the form of sulphurous acid, and if that is calculated into oil of vitriol, it will amount in one year to 240,000 tons of oil of vitriol, sent into the atmosphere of London alone, by the combustion of coal."

The extent to which the sulphur question is carried there, seems like a refinement of science, rather than a useful, practical protection of the public. The gas companies are tied down to the extremest limit, on grounds of public health, while thousands of houses are annually flooded with high-tides, heavy rains, etc., which sweep into permanent lodging places, within the habitation of the poor, the refuse—sometimes even the back-water—from sewers and drains. All of which result from

imperfect provision for taking care of this kind of impurity, by the same authorities who hold up their hands in holy horror, and exact a fine of £50 upon the unhappy gas company, every time they can find "an excess of sulphur."

A very singular fact exists, with reference to the sulphur impurities. The moment a city or municipal corporation acquires the possession of a gas works in England, all these restrictions disappear, and are no more spoken of. Bearing in mind the continued anxiety of the London manager on the purity question, and, that in some cases test analysis are made every hour, it is not strange if the details of the retort house received less attention. I think that with us, the motto is, "In the retort house is where the money is made;" or, perhaps more justly it may be said, "the retort house is where the money is *saved.*" It did not appear to me that there was as much economy there, as with us.

The charges are all "six hours;" the retorts are all "throughs." In several works, 20 men did the work for 96 through retorts, 192 mouth-pieces in twelve hours, or 4.8 retorts per man, for twenty-four hours. This includes drawing and charging, and quenching coke and throwing it back in the cellar. But the coal is in coal houses alongside the retort houses and has merely to be picked up and put into the retort. There is no bringing coal, or hauling out coke in this estimate, for it does not have to be done. The coal is there, and the coke goes into the cellar.

The buildings of some of the more recently constructed works, are very handsome and substantial structures, wherein beauty of architectural design has been combined with practical utility. Against this most commendable practice, there are not wanting those who complain that if the companies did not spend so much money on buildings, they would not have to pay dividends on so large a capital, and, consequently, they could sell gas cheaper. This, too, from a people who get good 15 candle gas for 87 cents per thousand, and do not burn it in any place, where they can avoid it, in their houses. Truly, it is somewhat difficult to please the ordinary gas consumer.

The use of gas in dwellings, is usually restricted to the lower parts of the house; and, either in hotels or private houses, as

you mount the stairs to retire, you are often confronted with a table filled with brightly polished candle sticks containing the "one candle power" that is to enable you to complete your correspondence, read your bible, and see you into bed.

In this fact (which must, some day, cease to be a fact), as well as the natural increase of population, and the steadily increasing application of gas to heating, cooking and mechanical purposes, is to be found the cause for the steady and rapid increase in "gas sold," that is found in London. This, I believe, will continue to be the case; and neither will the "electric light," nor petroleum convert the now busy places where gas works stand, into vacant lots, or grass-grown wastes waiting other occupants.

MR. NEAL—Do you mean to be understood that the price at which gas is sold here is cheaper, in proportion, than the price charged in London?

CAPT. DRESSER—That is a point that I do not wish to be misunderstood about. I tried to word that phrase very carefully. I say "I am under the impression that, when due allowance is made in the cost of coal and labor, and the difference in receipts for residuals, it will be found that gas is made as cheaply, in proportion, here as in London."

I am talking to a body of gas makers. My object in collecting these figures has been to get reliable information, and put it before you, so that each man can take the items and calculate for himself, and see exactly where he stands in comparison with London makers, so that, when people say to him, "Why, they sell gas at 90 cents in London," he will be able to have an intelligent answer to make, and he will be able to know whether he is right or whether he is wrong.

There is one thing I omitted to say, and that is that the statistics I have given here have been for the entire five years. It is interesting, perhaps, to note what the improvement has been in carbonizing during that period. Taking the results which I have summarized, we have the following figures:

Amount of gas sold per ton of coal carbonized (this is for 1873), 8,575; for 1877, the amount of gas sold per ton of coal carbonized, 9,333. These figures show that they are not standing still on the other side any more than we are.

MR. McILHENNY—Do you speak of a ton of 2,240 pounds?

CAPT. DRESSER—Yes, sir.

MR. GREENOUGH—It is not my intention to endeavor to add anything to the paper which Capt. Dresser has read, and which has been listened to with so much interest. But there is one point which, although he touched upon it, is worthy, I think, of a little closer attention.

Comparing the price of gas in London and this country, a very important question comes up, that was hardly dwelt upon sufficiently in his paper, and that is the interest on capital.

CAPT. DRESSER—I gave the amount of capital invested in London, per 1,000 feet of gas sold—$3.40—from which every man can calculate for himself.

MR. GREENOUGH—That is true, but at the same time its importance was hardly made sufficiently prominent. I had the pleasure this summer of hearing Mr. Livesey read a paper upon the proportion which the amount of capital invested in gas companies should bear to the amount of coal carbonized. Taking a large number of English companies, the conclusion he arrived at was that any well-ordered, and economically-directed company, ought not to have a capital of more than £ per ton of coal annually carbonized. I do not believe there are any companies in the country that can show such figures as that. Taking our own company, for example, which I think does a large business, the relation of capital invested to the amount of coal carbonized would be about £10 per ton. That, as everybody can see, is a very large matter, having a material influence upon the cost of gas in this country.

I do not know that it is necessary for me to add my opinion to what Captain Dresser has said in the way of comparison between the efficiency of our works on this side of the water, and the works upon the other side; but I think he is entirely justified in every comparison he has drawn between their retort house works and our own. The engineering arrangements of the works in England are on a much larger scale than those in this country, and the quantities of coal to be handled are very much greater. The process by which hand-power is saved, the coal distributed, and purification carried on, is such as to call forth

the admiration of everybody who sees it. But when you go into the retort house you are surprised to find that people who are so careful at the spigot are wasting so much at the bung. I thing the greatest mistake our friends on the other side make is in giving so much more attention to purification than to the retort house, where, as Captain Dresser says, our money is saved. I will simply mention one fact in this connection, which I think the members of the Association will appreciate at once. At one of the large works which I visited, the hydraulic main, which we are in the habit of watching pretty carefully in this country, was set on brick piers, built on the benches, and, of course, the main had settled or lifted with the bed and the consequences was they had a heavy seal on some dip-pipes, while others would have very little. I think that will serve fully as an illustration of what I mean.

I have taken the liberty of saying these things, thinking they might be of interest to the Association; but having opened my mouth on the subject, I do not want to sit down without expressing in the strongest language my appreciation of the hospitality with which we, as Americans, were received in London this summer. I had the pleasure of being with Captain Dresser and Mr. Forestall, of New Orleans, and there was nothing which the people among whom we went could have done that they did not do to make our reception of the most cordial and friendly nature. They extended to us every hospitality; they showed us around their works, and gave us all the information they could; they invited us to their homes, and they evinced the highest degree of interest in everything that was being done on this side of the water. And I have no doubt that any gentleman of this Association, who went there properly indorsed, would have received the same kind of welcome which was extended to us, and which made so great an impression upon us.

Mr. Price—I am very glad Mr. Greenough has made the remarks which we have just heard. As I understand the rules of our Association, after the reading of any paper the whole subject is open for discussion. He has alluded to a point which I feel a great deal of interest in. A gentleman asked me to

day, just before this meeting was opened, what I considered the elements of cost in making 1,000 feet of gas? I hope that trail will be followed up.

MR. NEAL—I understand that Mr. Forestall, who was with Captain Dresser and Mr. Greenough on their trip abroad, spent a great deal of time in the examination of the Paris gas works. He is prevented from being with us to-day by the ravages of the yellow fever. I understand that he had prepared, or was to have prepared, a very interesting paper upon that subject, to be read to us; and, perhaps, in this connection, it would be well for Captain Dresser, in the absence of Mr. Forstall, to give us some account of the Paris works.

CAPTAIN DRESSER—I would say that when Mr. Forstall was absent, Mr. Greenough was the Frenchman of the party.

MR. GREENOUGH—I think it hardly fair that any individious remarks should be made about the exceedingly small proportion of the French language that I am familiar with. In reference to the Paris works, I would simply say that Mr. Forstall was in Paris very much longer than I was, and he devoted much more study and attention than I did to the Paris gas works. I understood that he was to prepare a paper on that subject to present to this meeting. The number of gas works in Paris that I visited was very few indeed. My principal object, while in Paris, was to familiarize myself as much as possible with the working of the electric light, and not in any way to bestow careful attention upon the details of gas manufacture, and I was at only two or three gas works, and made but a very cursory examination of them. The necessity of utilizing their coke is so much greater than it is with us, and it is so much more important for them to save every pound of it that they can, that they have devised, as you all know, the most ingenious plans for saving it, and at the same time obtaining very high heats. The average temperature of their retorts was 135° C, or 2,500° F. Their retorts are 25×10×9 feet, and they are charged every four hours with about 270 pounds of coal. Their works present a singular contrast to the London works; and the impression which was left on the English engineers, who visited Paris in company with us, was very great, especially

when they found that in the works which we visited they had 1,100 retorts, and were making about 8,000 feet from each one of them, and that, too, with the use of only about 25 per cent. of coke as fuel; and I think that in the works where they were using either the Siemens furnace, or another similar one that was arranged by themselves, they saved about a quarter of that 25 per cent. The utilization of the residuals, coke, ammonia, etc., is so much of an object to them that the chief engineer of the Paris company, M. Arson, told me that his residuals paid him not only for the manufacture of his gas, but also for a very considerable portion of the cost of distribution. That is a result, the bringing about of which, I think, we should hail with enthusiasm in this country.

The impression left on my mind, after visiting the works in Paris and in London, was, that if we were to take the French retort house, and the English purifying apparatus, and run them in conjunction, we should have pretty nearly a perfect set of works. At the works at La Villette, the arrangements for purification were singularly simple, and small, as compared with those of the great London companies. It is my recollection that the only purification to which the gas was subjected was that of oxide of iron. Charging, as they do, their retorts every four hours, instead of every six, as the English do, it was contended by the French engineers, and, I must say, I think with entire correctness, that the amount of bi-sulphide of carbon was very much less in the French gas than in the English. That assertion was at once contradicted by the English engineers who were present; but it is my impression, notwithstanding, that the Frenchmen were entirely right.

I have very little to say on the subject of these French gas companies. The relation of the Parisian companies with the public I suppose you are all familiar with It simply amounts to this, that the Parisian company in 1853 or 1854, contracted to supply Paris with gas for fifty years. They sell to consumers at a price equal to about $1.75 per 1,000 feet, and they supply the street lamps at half that price, I think. They are allowed to pay 10 per cent. dividends to their stockholders, to provide for a sinking fund, with which their stocks shall event-

ually be redeemed, and also to provide for all repairs that are necessary; and then any extra dividends which they pay beyond that, they are required to divide equally with the city of Paris. That, of course, gives the city the interest of a partner of the company. The amount of money which was paid to the city of Paris last year by the companies was, I think, 8,500,000 francs, which a little more than paid for the gas they burned. You thus see that they made some money by the operation.

Capt. Dresser—They paid for the gas they burned at about the rate of 87 cents ; then what they got from the division of profits, over and above the authorized dividends of the company, a little more than paid for the gas they used. So that under such a condition of things, it will be seen that it is to the interest of the city to burn as much gas as possible. The more gas they burn, the more money they make. [Laughter.]

Mr. Greenough—On the night of the great illumination in Paris, celebrating the anniversary of the Republic, when I happened to be there, the engineer of one of the companies told me that they were ordered by the city to furnish gas for 400,000 extra lamps that night. I believe that is all I have to say upon this point at present. I shall be glad to answer any questions that may be asked, so far as I am able to do so. One thing I had forgotten to say, and that is, they make the most beautiful exhibition of their residuals at the exposition.

They not only work their coal tar and ammonia water into ordinary products, but they also produce a species of fuel which is extensively sold throughout the country, at a very great profit, as I understand. Using their coke dust, and, I think their coal dust, and mixing with it the residuals of their tar stills, they produce blocks of this compound, which are, perhaps, about 12 inches square. These they sell to railroad companies for fuel. They are very easily stored on the tenders of engines, and you will see them in piles of thousands of tons around the large railroad stations in the vicinity of Paris. The working up of their residuals is carried on in the most exquisite way, and the products which they show are such, as to excite astonishment, that they can be produced from a source we are all so familiar

with, and from which we get so little. They make the most beautiful exhibition of their products in this line. We had the pleasure of being present at a luncheon which was given to the Societée Technique, and also, to the British Association of Gas Managers. The tables were spread in the new retort house belonging to the Parisian Company, at Ivry. I think the gentlemen who were present were very much surprised to see the extraordinary beautiful trophy which was there exhibited. It was on the brick wall at the end of the building, the extraordinary construction of it you would never notice, until you came to pick it to pieces, and see what it was composed of—rakes, stand-pipe augurs, shovels, etc. I would like to say, in this connection, that the hospitality with which we were received in England, was fully equaled by our reception at Paris. Nothing could exceed the courtesy and cordiality with which we were treated. I might say a good deal about electric light, but you will hear enough of that.

MR. PRICE—It has been said they manufacture all their material.

MR. GREENOUGH—They manufacture all their retorts and fire-bricks, not only for their own works, but for works at other places. They also sell some retorts.

CAPT. DRESSER—They make everything that they use. They make their own holders, their own fire-brick, etc.; and not only that, but they make gas stoves, and gas engines, and anything that will increase the use of gas.

MR. NEAL—Do they make money by the operation?

CAPT. DRESSER—I don't know; I did not get any from them.

MR. MCILHENNY—So much has been said by the gentlemen who have just addressed you, in regard to the manner in which they were received across the water, that I am tempted to say a few words upon that subject. I visited Europe three years ago, and I rise now simply for the purpose of making a statement that I have made privately to a good many members of the Association, in regard to the reception I met with. The expressions of the gentlemen who have been there since, have

been so unanimous with regard to the overflowing and spontaneous hospitality with which they were received, that I fear it is, perhaps, very ungracious for me to tell about the cool reception that I met with over there—in fact, no reception at all. They let me severely alone, and I could not account for it; but since Capt. Dresser has come back, it has all been made clear. He told me that he was told by all the people over there, that there was a gentleman visited them by my name, but that they thought he would not live to get back home. I think perhaps the lack of attention on their part, toward myself, was due to the fact, that they were afraid I would die on their hands, and they did not want a first-class corpse over there. [Laughter.]

CAPT. DRESSER—I would like to say one word in reply to what Mr. McIlhenny has said, and that is, that the treatment I received (and, so far as I have heard, the treatment that was received by the other gentlemen who were over there), from the moment I landed in Liverpool, till I left, was of the most hearty and cordial character. Everything that these gentlemen could do, in the way of giving information and allowing me to examine their books and papers, was done. Not only that, but they assured us, that if at any future time, anything came up in regard to which American gas companies wanted any information, they would give us all it was in their power to give. We were invited to their houses, and were treated in the most sincere and courteous manner, in every way, and I cannot conceive of anything being more hospitable, than these people were to us on every occasion. In going into small villages, and into gas works where I was entirely unknown, by simply announcing myself as from America, and interested in gas matters, I was immediately received with the greatest cordiality, and shown everything. There is no single instance, where there was any different treatment received by us, The feeling seemed to be, that they could not do enough to return the hospitality that had been shown, not only to the members of the gas profession, but to other English gentlemen who had been in this country; and there was the greatest desire on the part of all, to promote good feeling and increase their acquaintance with gentlemen from this side.

Mr. Price—We would like to have Capt. White state how he was received. Let us hear from all sides of this matter.

Capt. W. H. White—I do not think it is necessary to again inflict upon this Association a narration of my experience upon the other side. It was certainly very pleasant. I had the advantage of beginning earlier than Capt. Dresser, and ending later. They took me ashore at Queenstown, and there they commenced a process of hospitality which they continued without intermission until I got around from Queenstown back to Liverpool. The last gentleman who saw me on board the steamer and asked me down stairs was a gas man, and the very first man that I took by the hand when I landed on the other side was a gas man. [Laughter.] I was received with the greatest courtesy and cordiality wherever I went. I had an opportunity to look into their methods of working, and I was shown over their works, and was shown their books, and was given all the information I wanted. It was only necessary for me to present my card and to say that I was an American gas man, to insure a cordial and hearty welcome. Their wives visited my wife, and every attention was shown that a refined hospitality could suggest.

I found some small gas works containing one retort, and I found the same courtesy there, and the same willingness to give me information that I found at the immense works at Beckton, where I was shown every courtesy and furnished every opportunity to make the fullest investigation. There seemed to be a rivalry among all the gas works I visited, as to which could treat me the best and show me the greatest kindness. I am sure I cannot fitly express my appreciation of the manner in which I was received everywhere. I am at a loss to understand why it was that Mr. McIlhenny was so cooly received. He accounts for it upon the theory that they thought he might possibly die on their hands. I don't look at it in that way. They probably thought that if he did die on their hands it would take all the good whiskey in England to preserve his body and send him home, and for that reason they were anxious to get him out of the country while he was yet alive. [Laughter.]

MR. DENNISTON.—I would like to call attention to one thing suggested by the remarks we have listened to. I think we all ought to try and get the consumers interested in the prosperity of the company. I have tried to do that by charging them $2.50 per 1,000 for gas, and giving them 20 per cent. off, so that, as Capt. Dresser has stated regarding the city of Paris, the more gas they burn the more percentage they get off. I think it is a first-rate idea to give them some inducement to burn more gas.

MR. NEAL.—I think the paper which has been read by Capt. Dresser, and the remarks of Mr. Greenough, suggest a subject which is very interesting to us—namely the utilization of residuals. In this country, why is it that our residuals do not command a greater price, and can there be any way devised by which they may be made more acceptable to the public, so that the gas companies can realize more from them, and in that way be in receipt of a revenue or income which will enable them to reduce the price of gas. It would seem as though there ought to be some means devised by which the farmer could be instructed in the use of spent lime and other residuals. I understand that in London the lime, after leaving the purifiers, brings a very good price indeed. So, also, with our other residuals, coal tar, etc. But if we could only sell our residuals at a fair price, we might give gas to our consumers at a much less price. Take, for instance, the sale of ammoniacal liquor. Some persons present have tried to utilize that. Mr. Sherman tried it, and he says it was a failure. Mr. McIlhenny is, I think, utilizing ammoniacal liquors at his works, and I understood that at one time it was very profitable. I would like to know whether that is the case now. I know I have tried to get several parties to take our ammoniacal liquor, and have given it to them at a fair price, but in every case it proved a failure. They would take the liquor for a while, paying a small sum for it, but in a short time they have abandoned it altogether.

MR. MCILHENNY—On the subject of the sale of ammoniacal liquor, I will say that we are still selling it to advantage. We sell our liquor at the rate of about ten cents per ton of coal carbonized, making an aggregate of about $2,700 a year that we are

paid for the manufacture of ammoniacal liquor. It has been a very profitable business. We are now putting up an acid chamber for the purpose of making acid. I think nearly all the companies of any size in this country are selling ammoniacal liquor. Of course the production of ammonia from ammoniacal liquor is very much like the production of gas from coal—it depends upon the yield you get. It takes so many pounds to pay expenses, and beyond that is profit, so that if you can get a good yield you can get a good profit, That is true in making gas from coal, or any other source. We are utilizing our residuals in that respect very pleasantly, and, I think, quite profitably.

MR. YOUNG—I think the great trouble in many cases is the lack of interest that we take in making our ammoniacal liquor of the proper strength, so that parties engaged in using it can make its use profitable. That, it seems to me, is the most important part of the business—to make the ammoniacal liquor so that it can be utilized by those desiring to purchase. We sell our's now, and get eight cents per ton of 2,000 pounds for it.

MR. PRICE—I will give you an account of my experience upon this point—in regard to the sale of ammoniacal liquor. A German came to our place five or six years ago, and proceeded to erect works for producing ammonia, and for utilizing our ammoniacal liquor. We made a bargain with him, by which he expected to give us about twenty cents a ton for ammonia, and we were to give him ammoniacal liquor at a certain strength. I think it was a sixteen-ounce or a fourteen-ounce liquor, but, perhaps, I may be mistaken about that. At any rate we were to give him the liquor at a strength at which he could work it profitably. It turned out that he did not know very much about the business, and when he came to get his works in operation he found that he could not pay any such rice for the liquor, and that he could not get the cost of it ack again. That was owing, however, partly to the fact that e price fell very rapidly. At that time in Cleveland sulphate of nmonia was worth about 6½ or 6¾ cents, and I think he de sales at even less than four. I did not want to have the rks stopped, and so, in order to keep them going, and in or-

der, if possible, to see if it were practicable to utilize ammoniacal liquor, even though we did not get a very good price for it, we finally agreed to let him have it at ten cents a ton, and we gave him the use of the building in which he carried on the operation. But I don't think he could really afford to pay more than six or seven cents, perhaps, to the ton.

Now, the great reason why ammoniacal liquor is not profitable, is, first, because ordinarily it is not made strong enough to justify working it; in the next place, because, as fertilizers are so little esteemed by the American farmer, the prices are very low. The western farmers have such rich lands that they do not care for fertilizers at all. In New England fertilizers are, of course, much more highly esteemed. But take the country at large, and especially all the western country, fertilizers are not greatly in demand. There is another residual upon which gas companies rely, and that is coke. Its value seems to differ in different locations. With us it has been a very valuable residual, but we are being interferred with by the low price of anthracite coal. We are now getting eight cents a bushel, where we used to get ten and eleven. But in order to make it more attractive, and to fit it for the market, I purchased last year a cracker, or crusher, which is run by a small steam engine, and which reduces the coke to small pieces. In that way I have succeeded in changing the market, because there are a great many more people get it now in that way than purchased it previously. The cracker reduces the measurement as a matter of course. We calculate that we lose in the measurement about 12½ per cent. by cracking—being equivalent to about one cent per bushel. We charge an extra cent for cracking. We sell the ordinary coke, for instance, at eight cents, and sell the cracked coke for ten cents. It is gaining in favor every day. We find the sales increasing, and the coke appears to be much more acceptable in that form. I mention the result of our experiment that others may have the benefit of it. I think it will be found to help the sales of coke very materially.

A MEMBER—How much does it cost a bushel to crack it?

MR. PRICE—Perhaps half a cent. It depends entirely upon

your facilities, and whether you have to employ new labor, and whether you can make use of what you already have. I don't think it costs us over half a cent. We are pretty well paid for setting up our machine and running it. The machine is made in Indianapolis, and the name of its maker is G. R. Root. That is, perhaps, the best machine that is made—that is, so far as my knowledge extends. It is quite effective. I will say, however, in passing, that, although he is probably entirely honest, yet I was misled by his statement that the coke would increase in volume after being crushed, although I did not exactly see how that could be possible. I was not quite able to understand how, when it was reduced to a small compass, it could measure more; but still, I took his word for it, and was disappointed when I found the reverse was the fact—viz.: that it diminished the measurement. But I finally concluded that, buying, as he did, his coke from Louisville and Cincinnati in large quantities, he probably got very large measurements, and therefore it was very likely true that, considering these large measurements, in buying and selling so many hundreds of bushels, he actually gained a little, and I accounted for it in that way. I think he is an honest man; I don't think he meant to mislead, but you will find in running the coke through the cracker that the volume will be diminished, and that you will lose about one bushel in eight. The dust is very small indeed.

The cracker cracks the coke into pieces about the size of walnuts and butternuts. The expense of the machine is about $250.

MR. C. WHITE—Speaking of residuals, and especially of coke, calls to my mind a little experience of my own in that line.)wing to the low price of anthracite coal, we have had conderable difficulty in getting rid of our coke. There is a hill, ·obably a half mile, or nearly that, in length, which we must cend before we can reach the top of the main level of our y. Our people did not seem disposed to come down and y the coke, and a large amount of it accumulated. I heard this crusher of Mr. Root's, and suggested to our company : we should send to him to get some information on the ect. We did get a circular from Mr. Root, in which he large results in relation to what could be done, either by

hand power or by steam power, from this crusher. We ordered one on the strength of that, to be tested, and paid for if found to answer our purpose. I took great care, in putting it up and testing it, that everything should be made to work as fairly and smoothly as possible. He claimed, I believe, that four men in ten hours could crush 1,200 bushels of coke by hand. I put two men to work on it—one to shovel the coke into the hopper, and the other to turn the crusher. I found that after one or two revolutions the thing refused to go with one-man power, and I put two men at it at intervals; but it did not do any better. No four men can begin to crush, in that crusher, 1,200 bushels of coke in a day. I merely give you my experience as to the working of the machine *by hand power;* how it works by steam power I cannot say, because our facilities are such that we cannot use a steam engine.

MR. PRICE—I should hardly think it would be worth while to set up the machine, unless it was used in connection with a steam engine.

MR. C. WHITE—There are a great many of us that have not the facilities for running an engine in connection with the crusher. The result of my experience with the Root crusher was, that from it I got an idea of how I would better it, and I went to work and got up the patterns, though I have not applied for a patent. I hope it is understood that I am not selling a coke crusher. I make these statements simply for the reason that I think my experience in the matter of crushing coke may be of interest to the Association. Mine is a cutter and not a crusher, and its operation has proved very satisfactory. I find there is a loss in measurement of about ten per cent.

There was another fault I found in Root's machine. The balance wheel weighed about 50 pounds. It was of no assistance whatever in working the machine. I made mine 300 pounds, which I found was a very great improvement; so much so, that one man can stand on a platform and turn the wheel rapidly without trouble, while another man shovels out the coke. I can crush out 1,500 bushels of coke in one day with the machine in this way. I have figured the additional cost of

crushing the coke at 1½ cents per bushel, which covers every thing. I find, also, that it makes a great deal less dust than the other. In fact, I have it so arranged that the coke, as it comes through the crusher, falls upon a screen, and, running down, sifts itself. By this means my coke is perfectly clean, when it is delivered to the consumers. There is one thing I have not yet been able to succeed in doing, and that is in getting our people to put the price of this crushed coke up. We have so much on hand, that they think it would be better for us to get rid of it, even at the loss of 1½ cents. Therefore, we are to-day delivering that coke at just the same price as we are delivering the other.

MR. PRICE—Do you sell any more?

MR. C. WHITE—Very little; but we only got this machine up, and in operation, week before last, and, of course, we cannot tell much about it.

MR. PRICE—Of course, I do not pretend to say that there may not be some better machine than Mr. Root's; but when it is run with a light steam engine, it does very good work. We have it arranged so that the coke falls upon a screen, and the dust, consequently, falls upon one side, and the coke is upon the other. Have you patterns for your machine?

MR. C. WHITE—Yes.

MR. PRICE—Mr. Root's machine does very good work for us under the conditions I have named—run with steam power; still, if there is anything better, I think we are all interested in knowing what it is.

MR. WHITE—I have not had it patented, and have not even applied for a caveat. The idea just came into my mind, from seeing the defects in the other. I thought I saw a way of remedying them, and I set about trying what I could do in that direction. I worked out the patterns, and put the machine up, but, as I say, I only succeeded last week in getting it into operation, and have used it for only two or three hours at a time. I have, however, all the coke crushed that I can store away in what little space we have.

I do not wish to say anything against Mr. Root's machine. It may work very well with steam power (and we have Mr.

Price's word for it that it does), but it certainly does not work well with hand power. Neither do I wish to appear to be speaking in favor of the machine I now use. I am simply stating results.

Mr. Price—What is the expense of your machine?

Mr. White—I could not tell. It would not be over from \$85 to \$95. I have not determined the matter of price as yet.

Mr. C. H. Nettleton—I have also had a little experience, and it came about in this way: Our town is a small one, and our consumption is, of course, somewhat limited. The centre of population is at some distance from the works, and we depend a good deal upon the inhabitants of the immediate vicinity of the works for sale of our coke. We found that we could only sell our large coke to the factories, but in consequence of some of the factories not running last winter, it accumulated to some 4,000 or 5,000 bushels, which, for us, is a large amount. I heard that Col. Steadman, of Newport, was doing something in the way of breaking up coke, and also Mr. Slater, of Providence. I asked both of these gentlemen how they did it. Col. Steadman gave me a slight sketch of the means he employed, and the results; and I went and got a Newport machine. It cost me \$55, without the fly-wheel. I picked up a fly-wheel that answered my purpose sufficiently well, and the whole cost did not exceed \$65. We run it with a small four-horse power engine. It will break coke as fast as two men can shovel it in. I arrive at the loss in measurement in this way: I measured up 200 bushels of large coke as it came from the retorts, and after it had been put through the machine I had 179 bushels of broken coke, and 9 bushels of dust. I estimated the cost to be, including extra labor, at from 1½ to 2 cents. But it brought about this result, that there is a great demand for all of my coke. I have a very small amount on hand, not enough to last me more than two weeks, and before I got the crusher I could not sell my coke.

Mr. Harbison—I think the great difficulty is that gentlemen who complain of not being able to dispose of their coke, do not make a good quality of coke. We have no trouble whatever to dispose of our's. We have got orders enough on our

books for all the coke we shall produce in the course of six weeks. Even during the summer I am sometimes obliged to send to New Haven for coke to keep our customers supplied. It is brought by water and by rail. As I said before, the trouble is that the gentlemen do not make good coke.

Mr. Price—Perhaps Mr. Harbison will tell us how to make good coke.

Mr. Harbison—Buy a good quality of coal, burn it for the proper length of time in properly constructed retorts, take all the gas out, and you will have good coke.

Mr. Price—I will say one word on that point. I am convinced there is a great deal in what the gentleman from Hartford has said. In the first place, unless you buy a good quality of coal, you will not have good coke. There is a great deal of coal used that is utterly unfit for gas purposes. It is used for various reasons : sometimes because it is very cheap, sometimes because stockholders of the gas companies are interested in the coal companies that sell this cheap coal, and sometimes, because hey are interested in the railroad that carries it. There are multitude of reasons why some gas managers use poor coal, ut in my judgment it is a mistake. The best coal is, I think, generally the cheapest, even though it may cost something nore. We use Youghiogheny coal, and I do not think there is ny better coke made in the United States, with all due respect o my Hartford friend. But just across the river from us, not nore than a hundred rods distant, where they were using a ifferent coal, there was a good deal of complaint about the oke they made, and the people who naturally would have ought coke from them came to us; and when we asked them hy they came to us to buy coke, they said it was because the oke at the other works was not good. I think it was partly ecause they used poor coal, or at any rate, inferior coal ; and artly for another reason, which sometimes may hold good in orks, besides those I refer to, and that is this : the works were nall, and the men who had charge of the coke and threw it ut went back to the fill retorts. The works were not large nough to employ sufficient labor, so that a number of men ould be filling the retorts while the others were taking care of

the coke. The result was that the coke was neglected, and was left to take care of itself while the men were filling the retorts with coal, and consequently it was often burned Of course we all know the importance of taking proper care of the coke, and taking it out just at the right time. If this is neglected, of course, we cannot expect to get good coke. I have said this because I think the observance of proper care in this respect is almost as necessary to the successful handling of the coke after it leaves the retort as to have a first-class quality of coal.

Mr. Breese—I suppose a good many members of this Association know how to make good coke. For my own part, I would like to know a little more about making ammoniacal liquor. I would like to know what strength it should be made in order to be most useful to those who may desire to purchase it, and what the cost would be in economically managed works. I can make coke, probably, as well as the rest of the members of the Association, and sell all I can make, but I do not know a great deal about making ammoniacal liquor, and some of my friends do not know much more. I, for one, would like a little more information on the subject, and if Mr. McIlhenny or Mr. Price, who have had considerable experience in making ammoniacal liquor, would give us a little more, in detail, their results in regard to the amount they can make per ton, the strength that it should be made, and what it cost to make it, they would help some of us very much.

Mr. McIlhenny—I think there has been rather too much stress laid upon the amount of information I possess upon this subject, but what I have, I am perfectly willing to give to the members of the Association who desire it. In the first place, to make ammonia you must have facilities. These facilities consist of *effective scrubbers*. It will depend largely upon the efficiency of the scrubbers as to the quantity that can be produced per ton of coal. There is no cost, I may say, in producing ammonia. All that is required is a pump, to pump the liquor over. It is one of those things that come voluntary, as it where. The way that we manage it is very simple. We have two scrubbers, 46 feet high by 12 feet in diameter—plain cylinders filled with slats. These slats are about 4 inches

wide, and are laid flat; and each slat protects the opening of the one below it. This is a much better plan than to put the slats on edge, because the gas must necessarily impinge against the bottom slat in going up through the scrubber. The water coming down on the top keeps the slats always moist, and the gas must come in contact with a moist surface. By this means you can, with the scrubber that you re-pump the water in, take about 10 grains of ammonia out of the gas. In the next scrubber we put in about 1 gallon of water to 1,000 feet of gas made. From this we make from a 5½ to a 6-ounce liquor. I would state that the strength of the liquor will make no difference with regard to the quantity of ammonia you may obtain. It only requires a little more fuel to vaporize it. It is a mistake to suppose that you must have a very strong liquor. My impression is that the weaker you have the liquor, the more ammonia you will obtain, because less will pass off with the gas. That is the process by which we make it. There is no expense attached to it whatever. It flows into the scrubber in the form of gas, and passes out in the form of a liquid, and the process is simply to pump it over, using two scrubbers. You must, however, have the scrubbers, and they must be properly constructed. We make at our works about 20 pounds to the ton of coal carbonized. The process of making salts, of course, the gentlemen present understand as well as I do, but perhaps my friend would like to have a word of explanation in regard to that. The water passes into wells (we use three wells) so as to thoroughly separate the tar. We first pass all the products of the works—ammonia water, tar, and everything—into one well, and then we let the ammonia water run into an adjacent well, and from that well it runs into a regular receptacle for it, and from that it is drawn into boilers or stills. These stills are horizontal boilers, without tubes or flues—plain cylinders. A fire is built underneath, and the ammonia is vaporized and passes off through the still into the vat. All the steam from this boiler passes into the vat, and there the ammonia is arrested by sulphuric acid, and the salts are formed. That is the whole process. After the salts are thoroughly crystallized the covers are taken off the vats. The process is very simple. Any intelligent man can make ammonia salts and am-

monia water. The important part, however, is the scrubbers; and it is essential that they should be properly arranged and of sufficient capacity.

A MEMBER—I would like to inquire whether the gas leaves the scrubber absolutely free from ammonia?

MR. McILHENNY—No, sir; it leaves the scrubbers with from four to five grains. It is never free from ammonia, with us. We have from two to three grains after it leaves the purifiers. It averages from two and a-half to three grains.

MR. PRICE—Is the two to three grains delivered to the consumer?

MR. McILHENNY—Yes; about two and one-half grains. We are restricted by law to five grains, and we must keep within that.

MR. WOOD, (of New Bedford)—The gentleman last up seems to understand the subject of making ammonia, very well. I would like to give a little of my own experience, and have him tell me how I am to get in the right direction. At any rate, a comparison of our views or experiences may be of some service to the members of this Association.

I represent a small gas works, where we make from 70 to 80,000 feet per day. We have but one scrubber, ten feet high and about five feet in diameter. Last spring we commenced using ammoniacal liquor to wet our scrubber with, and we found that our liquor, as we make it from the condenser and the hydraulic main (running as Mr. McIlhenny has stated, into one tank, then into a second, and then into a third, for use), is about 2° Twaddle, as it comes from the condenser. We pump it off into a tank, and run it into the scrubber. We find that we can clean our gas from ammonia just as well in that way, as we were doing with the water from the city. We get along very well until we get it up to 4½° Twaddle. and when it gets there we cannot go any farther with it. It stops operation, both as regards sulphur and ammonia. We have to stop there and draw off the water and put in fresh. I want to ask if there is any way by which we can purify this liquor? I have heard gas men talk about getting the liquor up to 16° Twaddle. We cannot get that. We can get about six, but the operation is then suspended. It

does not take the ammonia; it does not take the sulphur. Last week we ran clear up until it stopped its operation, and we found that we were then nearly 5° Twaddle, and the ammonia went up to four grains. We changed, and took the other water, and it went down to 0.4 of a grain, and remained so, and was so when I left: and the sulphur was about four grains. I want to know whether there is any way by which we can purify this liquor any further, or whether it is better to let it go and make new when you get to that point.

MR. SHERMAN (of New Haven)—In this connection I will give my experience in regard to making ammonia. At one time I was selling our hydraulic main liquor at 25 cents per barrel, to parties who utilized it in manufacturing. That was when I was at Worcester. They told me to bring up the liquor to ten ounce strength, and they would give me one dollar a barrel for it. I put up a scrubber, a description of which, I found in the English *Gas Light Journal*, which consisted of a cylinder 20 feet by 6, which was all the space I had for it. I had no difficulty in producing a ten-ounce liquor. I sent the party down a sample lot, and he informed me he could not use it, that it was so highly charged with sulphur that it stopped his stills, and so the experiment proved a failure. But I wish to state, that my short experience should not be used in any manner to discourage any other attempts to utilize this product. Another thing which must be taken into account, is, that the state of the market prevailing at that time was entirely different from what it is now. For instance, one of the chief elements of cost in the manufacture of sulphate of ammonia, is the acid. At that time—in 1873—I paid three cents a pound for acid, and only got four and one-half cents a pound for the product. I carried the business on for a few months, and, finding there was no profit in it, I abandoned it. In the present state of the market, you can buy acid here for one cent a pound, and you can get about four cents a pound for your product. That leaves quite a handsome profit, and besides, you get rid of the ammonia, which I think is very desirable. We found that our bill for lime was very materially reduced at Worcester, after we adopted this process. We found that a considerable amount of the sulphur impurities were taken out in connection with this washing.

We did not pump our liquor over. We used pure water, at the rate of one gallon to 1,000 feet, and it came out a ten-ounce liquor. I investigated the subject again, during the past summer, with the idea of going into the manufacture of it again; but, owing to the very contradictory reports which came to me in regard to the price, I thought it best to close in with an offer which we have of ten cents for our liquor.

Mr. Neal—We have several papers to be read. Enough time has, I think, been given to this subject of residuals, growing out of the reading of Captain Dresser's paper. I therefore move that the thanks of this Association be tendered to Capt. Dresser for his interesting paper on London Gas Works. Carried.

Mr. Price—Before we pass from this subject, I think there ought to be something said about the six hours charges that are spoken of in the paper. It seems to be an extraordinary length of time, and I should like to know if anybody's experience justifies it. The statement struck me with surprise, because my attention has recently been called to some experiments made at our works, by our engineer, upon that very point. We have experimental works, and our engineer turned his attention to the question of how long it was desirable to run charges, and he found, by careful experiment, that the best part of the gas was made in one hour and twenty minutes, and that during the latter part of the time there was very little gas made, and that what there was, was of very little value. So we discussed the question between ourselves, whether it would be more economical to run three hours instead of four, because there would be a large saving of time and labor. But we decided not to undertake it. I think, however, it has been pretty clearly demonstrated with us that it is not only of very little use to run more than four hours, but that it would be a great waste. I was, therefore, greatly surprised when I heard the statement that the English companies run six hours.

Mr. Herzog—I think, in dealing with this matter, the number of pounds of coal in a charge should be taken into consideration. Coal wants a certain amount of heat to be carbonized thoroughly. Now, if you put in a small charge, there will

be a larger heated surface than if you put in double the amount of coal. Of course, if you put in a heavy charge, it will require more time to carbonize it. You can regulate it by increasing the number of pounds or reducing the number of pounds. Last summer I put in some charges, but after four hours I found that they were not quite burned out. I made a slight change; I took 25 pounds off of the charges. The result was that I got an increase of illuminating power and a larger yield of gas. I concluded that the reason of it was, that in the case of the smaller charge, there was a smaller heated surface, and the coal was more thoroughly carbonized than it was when larger charges were put in. It is probable that in England they put in heavy charges, and it is necessary to run them longer than four hours. Perhaps it may be explained in that way.

Mr. Greenough—In the English works they put in about 225 pounds of coal every six hours. The retorts at Beckton, if I remember correctly, were about 14x24. There is one explanation suggested to me by a French engineer in regard to the running of six-hour charges in the English works. It is this: That the dividends of the English companies were guaranteed, and consequently the larger the amount of money that was invested in their works the better they like it. I think his explanation is worthy of attention.

Mr. Neal—The next paper is by Mr. Chambers, of Trenton, on "Facts in Regard to Water Gas," etc. Before he reads his paper, to try the sense of the meeting, I move that when we adjourn this evening, we adjourn to meet in the hall in the rear of this building. I think the committee to whom the matter was left have decided to recommend that we hold our sessions there. Had we known that we should have been so much annoyed by the heat of the room and the noise in the street, I should have made a motion before adjournment this morning to meet in the hall this afternoon. Carried.

Mr. Coggshall—I trust the Association will not overlook the importance of the matter of unaccounted-for gas. The committee which was chosen two years ago have not accomplished anything, and I now move that a committee be chosen, composed of the following gentlemen: Mr. C. White, of

Rochester, Mr. A. C. Wood, of Syracuse, Mr. Isaac Battin, of Albany. I name these gentlemen because they are in close proximity to one another, and they can therefore consult together, and accomplish much more than if they were scattered throughout the United States. Carried.

MR. BREESE—Would it not be well to appoint as members of that committee gentlemen who come from all parts of the United States and Canada? I would like to have the extreme south and the extreme west represented, so that we could have the diversified opinion of the whole country. We would like to know what the results are in different kinds of soil. I think that the character of the soil has a good deal to do with leakage. I would therefore move as an amendment that a committee of five be appointed instead of three.

MR. PRICE—It is too late to move an amendment.

MR. BREESE—With the permission of the Association, I make this suggestion for their consideration.

MR. COGGSHALL—That experiment has been tried, and has proved a total failure. The very object of the appointment of these gentlemen was to have a committee, the members of which were within easy communication with each other. I think that such a committee will accomplish far more than a committee scattered as Mr. Breese suggests.

MR. PRICE—Of course it is not expected that they will confine their investigations to their own locality and their own experience, but they will endeavor to collect information from all parts of the country and abroad. The advantage of having the members of the committee within easy reach of one another must be obvious.

MR. CHAMBERS (of Trenton, N. J.), then read a paper, on the subject of "Water Gas," as follows:

ON WATER GAS.

The making of illuminating gas by the decomposition of water, with an admixture of petroleum or its products, is a subject that more than any other, connected with their business, has claimed the attention of the managers of gas light companies, for several years past.

It was a topic in existence at the time of the organization of this Association, and year by year came up at its meetings for discussion.

At the meeting in October, 1876, the Association, after a long debate, seeming to have become weary of the matter, abandoned its further consideration.

It may now, after the lapse of two years, be not amiss, briefly to consider the progress that has been made, and as far as possible, judge what success has attended the efforts of those who are earnestly trying by this mode, to improve and cheapen artificial light.

And upon what in the material world can man more nobly expend his powers of mind and body, than in the production of light; that ethereal and subtle essence which, when "the earth was without form and void, and darkness was upon the face of the deep," burst forth upon chaos at the Almighty fiat, "Let there be Light'.' "And God saw the Light which he had made, and behold it was very good."

Not thus can man decree. A creature himself, he must be content when "the greater Light which rules the day" withdraws his shining, to dispel the darkness of the evening hours, with such light as he can extract from substances made ready to his hand by the Creator.

No wonder then that such mighty efforts are put forth to improve the modes of producing light by human skill.

Absence of light—is darkness; and we find in Holy Writ, that darkness was one of the plagues visited upon Pharaoh and his people; "and there was a thick darkness in all the land of Egypt, three days; they saw not one another, neither rose any from his place, for three days."

With the origin, progress, and present attainment of the coal gas manufacture, you are all familiar.

Let us now, as briefly as possible, review the past history of efforts in the manufacture of what we may call, in a general way, Water Gas; and thus put ourselves in a position to understand the progress that has been made.

The first experiments in the making of Water Gas, were made in England, about the year 1823.

In a report made to the Manhattan Gas Light Company, of the City of New York, in the year 1864, by Professor John Torrey, Carl Shultz and Henry Wurtz, is enumerated a list of sixty patents, for plans and devices of water gas apparatus, of various dates, during a period of thirty-six years, from 1823 to 1859.

Mr. Hughes, in his treatise on Gas Works—3d edition—states, that about 1854, the hydro-carbon, or water gas process, was in great favor in England, and very sanguine expectations existed of its success; and that among its supporters were the celebrated Dr. Franklin and Mr. Samuel Clegg.

Mr. Clegg's estimate was that 75,000 feet of 12 candle gas could be produced from one ton of Boghead coal, when submitted to water gas treatment.

The towns of Ruthin, Southport, Warminster and Dunkeld, were lighted with the gas, and a number of companies, among them the Manchester and South Metropolitan, made trials of the system on an extensive scale.

The results in all these cases failed to be satisfactory, and the operations were abandoned.

Among the numerous patented devices for producing water gas at that time, was one by a French chemist, M. Joseph Pierre Gillard. His invention is thus described by Mr. Hughes:

"With the view of obtaining hydrogen more economically, M. Gillard erected a cupola similar to those in iron foundries; this was filled with coke or charcoal, ignited, and the fuel brought to a state of incandesence by a fan, or blower; after which (all passage to or from the atmosphere being closed), steam was admitted at the lower part, and passing through the volume of fuel, was decomposed, when the hydrogen and carbonic acid, with which it was impregnated, were withdrawn by an exhauster from the upper part of the cupola.

"From time to time the supply of steam ceased, and air was furnished by the blower as before, to bring the fuel to the proper degree of temperature for the decomposition."

It is easy to recognize in this cupola, the present "Lowe" gas generator.

From 1834 to 1839, extensive experiments were made upon the continent of Europe with the process of M. Jobard.

The towns of Dijon, Strasburg and Antwerp, and two districts of Paris, were supplied with gas made under his patent.

It was claimed that by this process 55 cubic feet of highly brilliant gas could be produced from each pound of resinous or mineral oil, capable of yielding alone only 7 feet.

After five years of trial the plan failed.

In 1860 an effort was made to introduce the manufacture of water gas under the "Sanders process," into the Philadelphia gas works.

The carbonaceous material in this case was rosin.

The owners of this patent proposed to make this gas equal in every respect to the gas ordinarily made at the city gas works, at a cost of thirty cents per thousand feet. Experiments made at the gas works were not successful. The promoters of the process charged the chief engineer of the city works with obstructing its success, and a violent controversy arose, which was carried on through one of the newspapers for nearly three months.

At length, a small works was built at one of the hotels, and a part of the building lighted with the gas.

A few extracts from the newspapers of that day, will show the flattering estimate placed upon the gas.

From the *Phil. N. Am. and U. S. Gazette*, of July 31st, 1860.

"*The Water Gas.—A Brilliant Light at the Girard House.*

"These lights were commenced three weeks ago. Some days elapsed before the tar produced by the coal gas was cleared out of the pipes; and now we have this wondrous discovery, the water gas, in all its glory, diffusing light and cheerfulness everywhere around.

"Its influence extends far and wide, for the brightness is of a white, clear, pure and penetrating character, before which, even distant darkness flies away.

"One great advantage too, is its cheapness; the price being much less than that of the gas made from bituminous coal. The economy is derivable.

"First.—From the superior productive power of the retorts.

"Second.—From the decreased proportion of labor.

"Third.—From the decreased capital required in original construction.

"Fourth.—From the decreased cost of gas material.

"A reduction of four-fifth in cost of material, transportation and labor, will doubtless secure its introduction to many regions now but partially supplied with this great agent of social progress, enlightenment and comfort."

From the Public Ledger.

"The quality of gas appears to be good, giving a strong and brilliant light.

"Those interested in its manufacture, state, that the actual cost of its manufacture, exclusive of labor, wear and tear of retorts, etc., will not exceed twenty-eight cents per thousand feet."

From the Evening Bulletin.

"A more brilliant light than that seen every evening from the burners supplied from this source, could not be desired.

The proprietors of the Girard House are already satisfied that it costs much less than the gas furnished from the city works."

From the Press.

"The peculiar merit is, pure light produced with a maximum of labor, and in this city at five-sixths of the cost of ordinary consumption."

Correspondence of the *New York Tribune*:—"It has been demonstrated that this gas can be produced at forty cents per one thousand cubic feet."

Notwithstanding the encomiums so freely bestowed upon the gas, it made no further progress in Philadelphia, and soon disappeared.

The files of the *American Gas Light Journal* for the years 1861 and 1862, contain much discussion on the subject of water gas. Then for a few years, not so much was heard about it, though new inventors were preparing to enter upon the scene. A new ally, also, was found in the natural oil from the wells of Pennsylvania, which, by affording cheap material for enriching the water gas, raised the expectations of inventors, and incited them to renew their efforts.

In 1874 several patented processes were brought to the notice of gas light companies, and their merits urgently set forth. Prominent among those, was the one known as the Lowe Process, and it is in regard to this process I now propose to give such facts as are in my knowledge.

At the outset, let me state what the process was claimed to be able to perform.

I can perhaps best do this by extracts from letters received from an agent:

"Presuming that you have an average daily consumption of 100,000 cubic feet, at a cost of $1.00, the result would be $100.

By the Lowe Process it would be .	$26.
Showing a daily saving of	$74.
Or, per week, ...	$444.

But this only shows the saving in the first cost of the gas. The subsequent saving in labor would be very great; I cannot even guess how much. Two men, or well-grown boys would be able to do all the work. By this process, there is absolutely no residuum, no debris, no lime, no coal tar, no dust, no dirt, no drips—nothing, in short, but to make money quietly, pleasantly and acceptably to the public whom you serve.

"You could dispose of nine-tenths of your real estate, all of your retorts, etc., and divide twenty-five to fifty per cent. per annum."

Speaking of a works then in operation, the agent wrote: "The townspeople are delighted, the gas is magnificent, and applications to introduce it are thronging in, very much to the satisfaction of the company."

Reducing these enthusiastic, and somewhat incoherent statements, to a plain, matter of fact standard, their claim is, that gas can be produced of as good quality, at much less cost, and with a smaller outlay for works, by the mode proposed, than can be produced by the coal method in common use.

Let us now try to ascertain how far these expectations have been realized.

It is unnecessary for me to narrate the steps by which, in December, 1877, the Trenton Gas Light Company found itself the owner of a gas works, built exclusively for the purpose of making this gas. This works was put into operation in December, 1876, and by the December following, had obtained about 350 consumers.

The works and apparatus consisted of a generating house, 40 × 35 feet, containing one steam boiler and engine, two trains of apparatus, each consisting of a generator, superheater, washbox and scrubber, a holder, street mains and consumers' meters, together with the necessary oil and coal storage.

The illuminating quality of the gas, though attended with some irregularity, has not been a matter of serious complaint. It is in the power of the gas maker to increase or diminish this quality of the gas, by using more or less oil; and hence, by skill and care, a good illuminating power can be commonly maintained.

In two respects, however, the gas proved to be unsatisfactory to many of its consumers.

One, was the stopping up of the tips of the burners with a pitchy, or a hard deposit, which rendered it necessary to frequently clean out or renew the burners.

In some instances, the house pipes became clogged.

The other, was its peculiar offensive odor.

For these reasons, many of the consumers applied to be changed back to the coal gas, and from December, 1877, to July, 1878, eighty-seven consumers were, at their own request, thus transferred. During the same period, there were no new applications for the introduction of the water gas.

In view of this result, it must be conceded that this gas is not as acceptable to the consumer, as gas from coal.

The only measurement of the gas from this works, is by the consumers' meters. Hence, any calculation of its cost must be upon the amount of gas sold—the unaccounted-for gas being an uncertain element in such cost.

For the quarter ending December 31, 1877, there was sold of this gas, 2,600,000 cubic feet.

There were used in making 14,930 gallons of oil, at 8½ cents ($1,269.05), 246,240 lbs. of coal, at 20 cents per hundred ($492.48); being for material. .	$1,761.53
There was paid for wages, ...	591.50
Making total cost, ...	$2,353.03

Being at the rate of	90.5	cents per	1,000 feet.
Or, for oil and coal, .	68.0	"	"
For wages, . .	22.5	"	"

For the quarter ending March 31, 1878, there was sold, 1,592,000 cubic feet.

There was used in making 9,019 gallons of oil, at 8 cents ($721.52), 150,140 lbs. of coal, at 17 cents per hundred ($255.23); being for material, ...	$976.75
There was paid for wages, ...	533.50
Making total cost, ...	$1,510.25

Being at the rate of	94.9	cents per	1,000 feet.
Or, for oil and coal, .	61.4	"	"
For wages, . .	33.5	"	"

The whole amount of gas sold, from the starting of the works in December, 1876, to the 1st day of July, 1878, (being a period of a year and a half), was 9,704,000 cubic feet.

The amount paid for making was:

For oil, ...	$4,701.25
For coal, ...	1,665.05

Being, for material,	. . . . .	$6,366.30
And for wages,	. . . . . .	2,445.00
Making total cost,	. . . . .	$8,811.30

Being at the rate of 90.8 cents per 1,000 feet.
Or, for oil and coal, . 65.6 " "
For wages, . . 25.2 " "

A further item of expense, which is peculiar to patent gas, must be added to this cost, for the royalty to be paid for the right to manufacture, or for the purchase of the patent.

These three statements are sufficiently near each other in proportions, to show a good degree of regularity in working, and are submitted, not as good or bad in themselves, but as facts of practice.

Any gas manager, by taking the same data, can compare these results with his own, and judge whether the promise of much lower cost has been fulfilled.

The claim of smaller outlay for building works is hardly worthy of consideration.

The two sets of generating apparatus in the works under review have each a productive capacity of about 70,000 feet in 24 hours—being for the two, 140,000 feet in the same time. Upon about the same space could be built four benches of retorts, of modern construction, capable of producing an equal volume of gas.

Should purification be adopted, equivalent buildings in that department must be constructed.

In no other parts of a works could there be any comparatively less construction.

If the results of the experiment which have now been laid before you are fair, it must be acknowledged that coal gas still holds its place in the advance; and that water gas, after half a century of effort, has not yet overtaken it.

It is to be regretted that the skill of inventors has not been able to bring about results equal to their desires.

By none would a large reduction in the cost of making gas be hailed with greater pleasure, than by the members of this Association.

It is the hope of improvement which brings us together, and makes this Association possible.

It is our product that chiefly concerns us, not the materia or means through which it is obtained.

It is the satisfaction of our customers and employers for which we strive, not the promotion of this or that process or invention.

The careful manager should be swayed neither on the one hand by prejudiced indifference, nor on the other by unreasoning zeal. While diligently seeking improvement, he should look with distrust on plans and schemes heralded forth with bragging boastfulness.

"Oft expectation fails; and most oft there where most it promises."

Let us then, "Prove all things; hold fast that which is good."

Authorities quoted—

"A treatise on Gas Works," by Samuel Hughes. Third ed, 1866.

"History and Value of Water Gas Processes," with appendix. By John Torrey, Carl Shultz, and Henry Wurtz. 1864.

"Report of the Philadelphia Gas Trust for 1861."

"The Water Gas Correspondence." Reprinted from the Philadelphia *North American* and *United States Gazette*. 1860.

MR. CHAMBERS also read several letters from consumers who were using the gas, complaining of the clogging of the pipes, the unpleasant odor emitted, etc., and asking to have coal gas substituted.

MR. NEAL—There was no residuals?

MR. CHAMBERS—No, sir; nothing of consequence—nothing that could be utilized. There are no means of making a photometric test of the gas at those works, and such a test has never been made. The main point to consider was whether it was satisfactory to the consumers. To all appearances the gas is about like coal gas, but it is liable to fluctuate, of course, as all gases of that kind would be, because they cannot regulate the amount of oil and the amount of steam to a nicety.

Mr. Price—Do you run the works?

Mr. Chambers—No, sir; we have not interfered with them at all. The same superintendent and the same men are there. All we did when we took possession of the works was to say to the superintendent, "Do the best you can." We furnished them everything they needed to carry on the work.

Mr. Price—Are you still running the works?

Mr. Chambers—Yes, sir. Since the paper I have read was written I have had an opportunity afforded me of obtaining information on two or three points connected with the manufacture of this gas. A week ago to-day the superintendent of those works called upon me and told me that if I would step around with him I could see one of the difficulties which they had to encounter, in regard to the obstruction that took place in the pipe leading from the works to the holder. I found the pipe was all dug up, and they were scraping out the inlet pipe to the holder with their hoes, and were clearing out a quantity of tar, or matter of some kind, which was beginning to obstruct the pipe. The other point was, that one of their super-heaters had failed to work, and upon taking out bricks from the inside it was found partially closed up with carbon. The point about that is this, that we do not, by this process escape the troubles that are incident to gas making from naphtha, from coal, and from other methods, but we find the very same troubles here. There is the stopping of the pipes and the clogging up of these super-heaters with carbon. So we see it is not all plain sailing by this process, any more than it is by the ordinary process.

Mr. Pearson—I would like to inquire if the gas is purified?

Mr. Chambers—No, sir.

Mr. Pearson—Did the gas go through any purification, except the operation of the scrubbers?

Mr. Chambers—No, sir.

Mr. Pearson—With reference to what you have said in regard to this obstruction of the pipes, and of the burners, could it not be traced directly to the want of purification? Would not the same trouble occur with coal gas, if it were sent to consumers without any purification, beyond scrubbing? I

am inclined to think there would be just as much trouble. I think it is a matter that deserves some attention at our hands, and while I am upon the subject, I will say that I have made some investigations in regard to this method of gas making. I have visited the Lowe gas process works, at Harrisburgh and Baltimore, and other points, with a view to ascertaining various facts in regard to the manufacture of gas by this process, and I have some data which I think will be of some interest to the members of this Association. I am not a Lowe gas process man, but I am seeking for light—for cheap light, and for good light—and I presume that every one here is actuated by the same motive, and that we are all willing to discuss this question, with a view to our profit and benefit, individually, as well as representatives of gas companies.

MR. PRICE—The hour of five o'clock has now arrived—the time fixed by resolution for adjournment—and I suppose the further discussion of this question had better be postponed until morning.

On motion of Mr. Neal, the Association adjourned until to-morrow morning, at ten o'clock.

SECOND DAY.

The Association met at 10 A. M., in the Fifth Avenue Hall, and was called to order by the President, Gen. Roome.

On motion of Mr. Neal, the reading of the minutes of yesterday's proceedings was dispensed with.

SECRETARY *pro tem*—Before we proceed to the discussion of the paper, I would like to give notice, as a matter of form, that the Executive Committee have submitted an amendment to the Constitution. It requires no action on the part of the Association, at this time; but our Constitution requires that notice shall be given of proposed amendments to the Constitution at one meeting, and that it shall be acted upon at the next. The amendment proposed is to Section II, and is as follows:

Insert, after the word committee, the following: "And that a change of at least one Vice-President, one member of the

Finance Committee, and two members of the Executive Committee, be made at each annual meeting of the Association."

There have been presented, properly certified and endorsed, for membership, Mr. Henry Y. Attrill, Director in the New Orleans Gas Light Company, and also, in the Laclede Gas Light Company, of St. Louis, Mo.; and Andrew A. Smalley, President of the Citizens Gas Light Company, of Newark, N. J.; and I move that they be elected in the usual form.

The motion was carried. The chair appointed Mr. Neal as teller.

The secretary *pro tem* cast the ballot as directed. Mr. Neal reported the gentlemen named duly elected active members of the Association.

THE PRESIDENT—There was a paper under discussion when we adjourned last evening—the paper read by Mr. Chambers, on the subject of "Water Gas."

MR. PEARSON—I am sorry that the discussion was not continued last evening, because there are some points in Mr. Chambers' paper, which, I fear, may have been forgotten. Before giving any of my experience, or the results of my investigations, I would like to ask Mr. Chambers a question or two, which, I suppose, he will have no objection to answer. I should like to know whether the cost per 1,000 feet of gas, which he stated to be 90 or 94 cents, was for the gas in the holder, or for gas sold?

MR. CHAMBERS—It was for gas sold.

MR. PEARSON—I should like, also, to know how the gas was measured; whether there was a station meter, or how the amount was arrived at?

MR. CHAMBERS—There was no station meter ever erected at those works; and, consequently, the only method of measurement was by the gas sold.

MR. PEARSON—Have you any idea of how much leakage there was?

MR. CHAMBERS—I have not; I don't think the leakage was very great; I believe the pipes were well laid, and that very little leakage took place.

MR. PEARSON—I should also like to know what the gas cost in the holder?

MR. CHAMBERS—I do not know, sir; I did not make any guesses as to any statement that I made here. I simply took the actual facts, from the practical operation of the works, as they were given me by the superintendent.

MR. PEARSON—Were those figures from the books of the old company, or from the books of the new company purchasing? What I want to know is whether these figures were the results of your own working?

MR. CHAMBERS—No, sir; the same superintendent has had charge of them all along. There has been no change in that respect since the company has passed into our hands. The superintendent keeps his own figures, and these figures, as I have stated, were given to me by him.

The two things are as distinct to-day as they were before we purchased.

MR. PEARSON—Who keeps the books of the old company?

MR. CHAMBERS—The books of the old company have been kept by the superintendent, as I have stated; the books of the new company are kept at their office.

MR. PEARSON—Did you not state, yesterday, that there was no purification of the gas?

MR. CHAMBERS—Yes, sir; I did. It was without purification. It was thought that purification was not necessary in that process.

MR. PEARSON—Then, I think, that sufficiently accounts for the trouble that was experienced by the consumers, because I found the very same thing to exist in Harrisburgh, where no purification was made; but, in other places, where they had proper purification, the same thing did not exist.

With the permission of the President, I should like to make a few statements in regard to this matter; and I will state, at the outset, that my attention has recently been particularly directed to the Lowe gas; and it is because we have made a conditional arrangement at Toronto, for its introduction, that I have asked these questions, and it is also partly on that ac-

count that I shall make the statements which I desire to make at this meeting.

About a year ago an effort was made to introduce the gas at Toronto, but we then declined entering into any negotiations with the parties making the propositions. We subsequently ascertained that at Kingston the gas had been in use, and one of our largest stockholders, the president of the Brockville Gas Company, made certain representations in regard to the cheapness and quality of the gas, which induced our directors to send myself and the superintendent to Kingston. Before I went I was thoroughly prejudiced against the Lowe process, and I had no idea whatever that the statements which were made were correct; but, after examination, I consider I had good cause to change my opinion. One matter that we had directions particularly to inquire into was whether the evils which Mr. Chambers has referred to, existed there; and on our arrival at Kingston, and prior to going to the gas works, the superintendent and myself went around amongst the consumers and inquired whether there was any trouble from the clogging of the pipes or burners. That was in September. They commenced making gas in January, so that eight or nine months had elapsed prior to our visit. In every instance where we made inquiries we found that the consumers were better satisfied with the gas made from the Lowe process than they were with the gas made by the old process. Perhaps the old gas was not very good; but I don't know anything about that After having made these inquiries we went to the works. I would say, at this point, that the manager of the works is a man of a great deal of practical experience, and is entirely reliable, I think there are gentlemen present who can testify to that. He has been in the gas business between thirty and forty years, and is very cautious about introducing any new process. Mr. Kerr, the gentleman referred to, gave us access to his books, and I took the record from them. Not only did I do that; but, in the process of the manufacture of the gas, I saw the amount of material weighed and measured; and, therefore, I can speak from what I actually saw, as well as from the results obtained from the books.

The figures that I took from the books were for the months

of June, July and August, of last year. The price of the anthracite coal used was $5 per ton, and the price of crude petroleum was eight cents per gallon. The coal for the month of June cost 15 cents, petroleum 22 cents, and labor 19 cents—charging a whole day's labor for a man only partially employed—making a total of 56 cents per thousand feet, not including cost of purification. For July (I give the totals and not the details) it was 54 cents. For August it was 51 cents. The amount of coal used, including that used for the boiler, was for the first month, 62 lbs. per thousand feet; for the second month 58 lbs ; and for the third month, 54 lbs. The number of gallons of petroleum used for the first month was 2-73; for the second, 2-69; for the third, 2-61 per thousand and the illuminating power of the gas, as tested by a Lowe jet photometer, averaged 16 candles.

The results of the other test referred to, when the coal and oil used were weighed and measured before us, and during the whole time it was being made, we were present, were as follows: Cost of coal, 15 cents, petroleum, 21 cents, and labor (charging for the time the man was actually employed), eight cents. Total cost per thousand feet (not including purification), 44 cents.

In March, last, I wrote to Mr. Kerr, asking if he was still satisfied with the process, and whether he had discovered any defects in its working, which he was not aware of at the time of our visit.

And, as he is not here, which I regret, perhaps it may be well for me to read the letter, or portions of the letter which is dated March 27th, which I received from him in reply, and this was after the works had been in operation for about 15 months. He says: "In reply to your questions, I say, first, I am still satisfied with the process, and have not found any special defects in its working. Second, I have not experienced any stoppage or clogging up of pipes, and very few of the burners have been effected. Indeed, I think we have less trouble in this respect than when we made gas from coal. The reports which you have received to the contrary, must either arise from prejudice or ignorance of the proper working of the system. I

have the same burners and taps in use, in my photometric room, that I had when you were here, and have never cleaned them; and for the last six months I have been passing the gas, to supply an experimental burner, through a glass tube, and, as yet, I cannot perceive the slightest trace of deposit of any kind whatever.

"I suppose you have also received exaggerated reports relative to its liability to condensation, and, consequently, its decreased illuminating power when passed from a warm to a cold temperature. During the last winter I made some experiments upon this point. I passed the gas from my photometer room, —the temperature of which, is generally between 65 and 70 degrees—to the yard outside, which reduces its temperature to several degrees below zero, and then through a series of pipes, in all, about 50 feet, and finally brought it back to the photometer; and the difference of the illuminating power before it went out, and when it came back, was very small indeed, and on several occasions it remained in the pipes, and exposed to the weather for a week at a time."

I visited Kingston again, in August last, and asked him whether he was still of the same opinion that he was when he wrote that letter, and he told me that, if anything, he was better pleased with the gas than he was at first. This is the testimony of a highly respectable gentleman and a man of long practical experience in gas making. Our directors, however, were not willing to introduce the process solely upon the reports received from Kingston, and I was therefore deputed, with our superintendent, to go to Baltimore. Our visit there, I will say, was unexpected, but we were allowed to go through the works and examine them. I made a record of what I saw, and the statement I am about to make, was taken from the books of the company, and not from actual observation, because, as a number of the generators were working continuously, and were charged at different times, it was impossible to get an accurate statement of the amount of naphtha and coal used, without referring to the books. I shall refer, with permission of the Association, to a copy of a report which we made to our board of directors, upon our return, containing the record I made,

which covers a period of about six weeks. The record shows that it took 47.60 pounds (say 50), of anthracite coal, at $3.50 per net ton, and 4.58 (say 4½), gallons of crude naphtha, at 4½ cents per gallon, to produce 1,000 cubic feet of gas. Seven men were employed on each shift, or 14 per diem, whose wages averaged $2 each. These men, we were informed, were quite sufficient to work eight sets of apparatus, capable easily of producing 600,000 feet per diem. This would make the gas cost as follows:

Labor per 600,000 feet, .	$28.00	
Per 1,000 feet, ...		4.64 cents.
Naphtha, 4½ gallons at, 4½ cents, .		20.25 "
Coal, 50 pounds, at $3.50 per ton, including fuel for boiler, . . .		8.75 "
Total cost, ...		33.64 cents.

This is the gas, not including purification, and I have no reason to suppose it to be otherwise than correct. We, with the engineer of the works, tested the illuminating power of the gas with Bunsen's bar photometer, and the average illuminating power, after corrections, was 22.31 candles. The engineer assured us that they kept the gas constantly at about that standard; and this I have no reason to doubt; as I have said before, our visit was unexpected. On testing the gas we found it free from ammonia and carbonic acid, but the test paper showed a slight trace of sulphuretted hydrogen. On inquiring among the consumers, we found they were well satisfied with the gas, and in no case had the pipes or burners been stopped up from use.

We went from there to Harrisburgh, Penn., and we learned the reason why the gas had not been successful there. I do not want to say anything against the conduct of the works, but I will simply state that the means of ascertaining the quantity of material used were not very complete.

There were two generators and super-heaters, with wash-boxes and condensers, *but no purifiers*, and consequently the gas was impure, and showed, on testing, the presence of a very large quantity of sulphuretted hydrogen. There was no station

meter, governor, or photometer, nor was the coal and oil used weighed or measured. The holder was only of 35,000 capacity, being much too small for the quantity of gas manufactured. We were informed by the superintendent that they used 4 1-10 gallons of naphtha and 65 lbs. of coal per 1,000 feet, and employed one foreman and three men. The gas being without purification, and being produced under these circumstances, I do not wonder that the people did not want to use it. I am sure I should have been very reluctant to do so, as I would coal gas without purification. Proper purification would have remedied the whole difficulty ; and I can only wonder that, with so effective a remedy within their reach, the company did not employ it.

As I have stated, we have made conditional arrangements with S. A. Stevens & Co., to introduce the gas in Toronto. They seem, at all events, to be very sincere in what they are doing. They have agreed to erect works themselves in Toronto, upon these conditions: That they shall produce 1,000 feet of gas from 4 gallons of petroleum and 60 pounds of ordinary anthracite coal, or 50 pounds of Indian Ridge coal, and that, if we cannot, on an average throughout the year, produce that amount of gas from that quantity of material, they will take their works down at their own expense, and not require anything from us whatever. They have so much confidence, evidently, in their own system, that they are willing to introduce the gas in Toronto upon those terms.

Now, let us see what it will cost with the present price of coal, and material, and labor in Toronto. So far as my information goes, it is just a question of cost. If soft coal is very cheap, say about $2.50 per ton, and if crude petroleum is from 8 to 10 cents per gallon, then, of course, it is more profitable to use bituminous coal, and make gas by the old system; but if oil and hard coal are relatively cheaper, then it is more profitable to make gas by the new process. At least, these are my views. I am willing, of course, to be corrected if I am wrong. Now, as to the question of cost at present prices:

Coal at, say, $5 per ton, would cost, per 1,000 feet	15.00 cents.
Oil, at 5 cents, would cost	20.00 "
Purification	02.00 "
Labor	04.64 "
Total cost per 1,000 feet	41-64 cents.

Now, the gentlemen here will know whether they can make gas from coal as cheaply as that or not. Perhaps some of them can, but I will frankly confess that we cannot do so. And if we find, that with the present price of material, we can make gas as cheaply as the amount I have stated, by the Lowe process, it will pay us to introduce it. Besides, we have this advantage : we have our coal works, and if we do not succeed in making the gas upon the conditions named, we can go back to the old process again.

Another point is this : I am informed that coke can be used in the generators instead of hard coal. I have been told that this has been done successfully at Indianapolis. If so, the cost of the gas can be lessened very materially, and coke, which cannot be sold, used profitably. We want to get the best gas, and, at the same time, the cheapest gas we can ; and we are quite willing in Toronto, to take the Lowe process on the terms at which it has been offered to us. It may be that at the end of the year our expectations will not be realized, but, at any rate, we shall gain experience, and cannot lose much. If I should be present at the next meeting of the Association, I will as frankly give you my experience of the process then, as I have now given you the results of my examination in this direction, which have lead me to form the conclusion I have arrived at. [Applause.]

MR. CHAMBERS—I hope Mr. Pearson's pleasurable expectations may be realized. I am sure no one would be better pleased than myself, to know how to manufacture this gas profitably, and do away with the complaints of consumers. We have purchased this plant at Trenton, at a great cost, and if it should result that gas can be made cheaper and better by the Lowe process, than by the old, I am sure we shall be very glad,

because we have the appliances for the manufacture of this gas at our command. It was not my intention, in the paper I prepared, to make any statements in regard to the scientific analysis of the gas, the results of photometric observations, or any thing of that kind ; but merely to give practical results.

MR. EDGERTON—I did not happen to be here yesterday when the paper was read by Mr. Chambers. In fact, I had understood there would be no further discussion of naphtha gas, and for that reason it was not my intention to attend the meetings of the Association ; but, hearing that a paper had been read, stating results that were unfavorable to that process of making gas, I determined to enter into the discussion, and give a few facts. The points I desire to make in regard to naphtha gas, are confined to facts and results entirely outside of the works. I do not wish, with but one exception, to make the slightest reference to any information to be obtained inside the gas works. What I have to say about the cost of the production of naphtha gas, can be demonstrated by that which can be learned outside the works; and the reason, I briefly state, is this—that if oil is passed through a red-hot retort, it is decomposed into two classes of gas—illuminating gas, and non-illuminating gas. I have found by numerous tests, that the percentage of illuminating gas is a fair indication, in fact, a more exact indication than can be had in any other manner, of the amount of oil used. Upon this basis I have made, since I have been in the city, quite a number of observations of the methods of making gas here from oil, and I will give you the result.

In the first place, I have made examinations and inquiries concerning the composition of a gas known as the "Tessie du Motay gas." I do not know why that name is given it, but it is manufactured at the works of the Municipal Gas Company. I found this gas contained 14.42 per cent. of illuminating gas, and of carbonic oxide 28 per cent. These figures, if proven, will be a pretty fair estimate of the value. Previous tests with water gas assured me that the carbonic oxide was in the proportion of 39.9 per cent. From that I considered the ratio of water gas to oil gas to be that of 28 to 39.9, and the balance of the gas to be the result of naphtha decomposition. Carrying these

figures out, I found the composition of the gas, as delivered to the consumer, was 70.2 per cent. of water gas, and 29.8 per cent. of naphtha gases. For the reasons given, the source of these two gases cannot be any other than that stated, viz., that the 70.2 per cent. must be the result of the decomposition of water, and the 29.8 per cent. must result from the decomposition of oil. Of this 29.8, the illuminating gases must necessarily be a part. They cannot come from water gas, for we know that it has no illuminating power whatever. Deducting the illuminant, 14.42 per cent., as above stated, from the total of the naphtha gases, 29.8 per cent., it leaves the non-illuminating product of naphtha decomposition 15.4 per cent.

Numerous tests and experiments have shown the total product from the decomposition of a gallon of naphtha to be from 70 to 80 cubic feet of gas.

As the proportion of naphtha gas found in Municipal gas was 29.8 per cent. of the whole, it follows that one thousand cubic feet of such gas consists of 298 cubic feet of naphtha gas, and the balance, 702 cubic feet, of water gas. The naphtha gas portion being yielded at the rate of 70 to 80 cubic feet per gallon, it would require from four to four and one-half gallons of naphtha per thousand. This gives, in my opinion, a basis to calculate upon, independent of any information derived at the works.

Now, the value of the gas is of the greatest importance because, in estimating the value of any product, it must be based upon the illuminating value of that product. On this point there is great difference of opinion. Most of the results and tests of naphtha gas in this country have been from Argand burners ; but that is not a true test of rich gas. It is so tested in London by the Gas Referees. The system of testing in vogue here is not a true one, as I can show you.

I found the illuminating value of the Municipal gas, as tested with a flat flame burner, set at an angle of forty-five degrees with the bar, to be as follows :

Pressure at point of Ignition.	Rate of Gas Consumption per hour.	Observed candle power.	Candle power per Cubic Foot.	Proportional candle power five cu. feet	Remarks.
2-10	2.06	10.000	4.885	24.425	45° Angle with Bar. Four feet Excavated Lava Tip, September 28th. ([1])
3-10	2.59	13.955	5.388	26.940	
4-10	3.28	17.800	5.427	27.135	
5-10	3.78	20.353	5.384	26.922	
6-10	4.29	23.132	5.392	26.960	
7-10	4.71	23.952	5.085	25.427	
3-10	3.70	20.080	5.427	27.135	Five foot Excavated Lava Tip, Sept. 28th. ([2])
4-10	4.52	24.780	5.482	27.412	
5-10	5.15	28.350	5.505	27.525	
4-10	4.52	25.590	5.662	28.310	Flat of Flame to Disc. ([2])
2-10	3.23	17.530	5.427	27.135	Six foot Excavated Tip. 45° to Bar. ([2])
3-10	4.20	23.270	5.541	27.705	
4-10	5.10	28.300	5.560	27.800	
5-10	5.86	32.570	5.558	27.790	
6-10	6.50	35.320	5.434	27.170	
3-10	1.34	5.250	3.918	19.590	Three foot Lava Fishtail. ([3])
4-10	1.58	6.262	3.963	19.815	
5-10	1.83	7.249	3.961	19.805	
6-10	2.04	7.490	3.671	18.355	
2-10	1.58	7.024	4.446	22.230	Four foot Lava Fishtail. ([3])
3-10	1.97	8.959	4.548	22.740	
4-10	2.28	10-550	4.627	23.135	
5-10	2.60	11.840	4.554	22.770	
6-10	2.93	13.133	4.482	22.412	
2-10	1.54	7.366	4.783	23.915	5 foot Fishtail, Lava Tip. ([3])
3-10	2.01	9.858	4.905	24.525	
3-10	3.762	9.811	2.608	13.040	NEW YORK GAS COMPANY'S GAS, September 28th, 3 to 5 P. M. 5 foot excavated Lava Tip Bat's wing. Test made at 2 miles distance from works. ([4])
4-10	5.062	13.103	2.588	12.940	
5-10	5.825	15.650	2.687	13.435	
6-10	6.912	18.074	2.612	13.060	
7-10	7.662	19.660	2.566	12.830	
8-10	8.312	20.920	2.517	12.585	

[1] Illuminating Power Meter, 22.750.

[2] The same gas, by Illuminating Power Meter, gave (1st series) mean of three tests, 23.160: Second series, three tests, 23.100.

[3] Illuminating Power Meter, at beginning, 23.62: Illuminating Power Meter, at end, 24.75.

[4] Illuminating Power Meter, 17.83.

SUGG ARGAND, "G." BURNER.—Gas rate, 4.95; Candle rate, grains, 120.6; Observed candle power, 22.860; Reduced candle power, 23.210.

NEW YORK EXAMINER'S BURNER AND METHOD OF OBSERVING.—18 C. Sugg-Letheby, Sept. 28th, 1878.—Gas rate, 4.31 Candle rate, grains, 119.7; Observed candle power, 15.96; Reduced candle power, 18-47.

It will thus be seen that the indications of the illuminating power meter are higher than the fishtail and bat's wing on poor gas, and lower with rich gas. This is also the view of Mr. Sugg, only he does not state the amount of difference.

MR. C. WHITE—Was the gas tested with an argand burner, or with a common burner?

MR. EDGERTON—It was tested with a flat flame burner.

MR. C. WHITE—Were both gases tested with the same burner?

MR. EDGERTON—Both kinds were tested with the same burner.

But by the method of testing in vogue in New York I find that the same gas of the Municipal Company would be stated at 18.47 candles; so then, it will be observed, the commercial value of the gas is stated to be nearly nine candles less for five cubic feet. This arises from the fact that the method in vogue for testing is without precedent. It is not used anywhere in the world except in New York.

Mr. Farmer has conceived a very good means of making comparisons readily—that is, as stated in candle feet—the amount of the product and the actual value of the product.

I will here state that I have been requested not to bring up this subject of Municipal gas. I shall, of course, discuss it so far as I shall deem it proper. I shall state nothing that I do not find outside the works. I do not come here to state what I find inside the works. I suppose the subject of naphtha and water gases is now under discussion, and whatever may be of use to the Association in that connection I consider myself at liberty to state. As I have said, the tests were all made with a flat flame burner, set at an angle of forty-five degrees with the bar. I consider that to be the fair way.

The London Gas Referees have adopted a method of using a flat flame to the disc. That magnifies the quality of rich gases slightly, and is not, therefore, the proper way. Hence, in considering this question of naphtha gas, you must take into consideration the fact that the commercial value of the product, as we find it, is double that of coal gases. I think that can be demonstrated beyond question.

Mr. White—At what price is the gas sold in this city?

Mr. Edgerton—I think they all charge a uniform rate for the gas per thousand. I have been informed that it was $2 25; but I have never paid a gas bill, and cannot speak from positive knowledge. I have heard the rate stated at $2.50 and $2.25. I believe that is all I have to say in regard to the question.

Mr. Helme—To ordinary mortals this question of naphtha and petroleum gas is a very perplexing one. It has occupied the attention of this Association, more or less, at every meeting for several years. We have heard the statement of Mr. Pearson. It was very straightforward, and looked as if it were honestly and fairly made; and I have no doubt he believes it. Every part of it may be true for aught I know; but there is one thing I would like to say, by way of reply, to some of the matters he has spoken of. He tells us he has been dealing with S. A. Stevens & Co., and speaks of the contract he has made with them.

Mr. Neal—Will the gentleman please suspend his remarks for a moment?

The President—I have the honor of introducing to you, gentlemen, Mr. W. W. Greenough, of Boston, who has been elected an honorary member of this Association.

In the name of this Association, sir, I greet you with a hearty welcome.

Mr. Greenough—Gentlemen of the Association: I have but one word to say, and that is, that I am very greatly obliged for the honor you have conferred upon me in electing me an honorary member of this Association. [Applause.]

Mr. Helme—Mr. Pearson stated that S. A. Stevens & Co. have made a proposition to him, which he thinks is satisfactory, and it does look to be exceedingly fair; but in the city of Philadelphia, where S. A. Stevens & Co. live, where they have started their business, and have carried it on to the present time, they had an apparatus in operation, with purifiers and station meters, and everything that they have about gas works, and everything they could desire to make their enterprise a

success. They ran it for eighteen months, or two years, in a portion of Philadelphia, and the citizens of that part of the town grumbled very much, and said it was not the thing they wanted at all. Finally, the authorities had to order them to take it away. They put it up there on the same terms that they proposed to put it up at Mr. Pearson's works.

Before I took charge of the works with which I am at present connected, they were making gas from rosin, and when I went into the business I found the same state of affairs existing, in regard to the warfare against coal gas, that exists to-day, and, I believe, will exist as long as any of us live.

In my rambles during the past summer, I came across a certain town where I found that the entire stock and works, which were designed to be run under the new process, belonged to two gentlemen. who had entire control, or were owners, of the patents for that part of the country; and, to my surprise, they were not using this process at all. I asked them why they did not make gas by that method, when petroleum was selling up there at 98 cents a barrel. They said they would have to pay very little more than that, but that they didn't choose to use that process; but why they did not, I don't know. They are gentlemen of means, and are making coal gas right straight along, with five retorts to the bench, and are making some money. It all amounts to this, that if they could make more money by using the patents they control, they would do so. From the fact that they are not using them, it is to be presumed that they are satisfied they can make more money by manufacturing gas by the old method; so that, notwithstanding the cheapness of petroleum, and the introduction of the electric light, I don't believe there is any business that is much better than making gas from coal.

Mr. Neal—While the subject of water gas is before us, I wish to say that the desire has been expressed by several of the gentlemen present, to visit the works of the Municipal Gas Company, of this city. I have spoken to the superintendent of these works, and he assures me that he will be happy to receive the members, at any time they may fix, either as individuals or as a body.

A Member—I have been informed that Mr. Fish has had some experience with this Lowe process; and think the Association would be glad to hear from him.

Mr. Fish—While I am perfectly willing to give to the Association the benefit of any experience I may have upon this subject, I am, perhaps, not very well qualified to speak of results in the way of practical gas making, for the reason that, while I have been connected with the gas business for some time, I am the commercial manager of our company, and not the one who has charge of the practical details of the business. My son, who is the engineer of the Utica Gas Light Company, was expected here until last night; and nothing was further from my expectations than to be called upon to make any statements at this meeting. I am not prepared to answer the gentleman who has asked for the information, except in a general way.

The Lowe gas process, which has occupied the attention of the Association for the last half hour, was in use at Utica for something like ten or eleven months. It was introduced there by Mr. Lowe himself. Mr. Lowe made a conspicuous failure with his first essays there at manufacturing gas from petroleum. He proved himself to be entirely ignorant on the subject and abandoned it. The gentlemen who had furnished the capital for Mr. Lowe's experiments, asked my son for further time to develop the merits of the process. The time in which he had stipulated to demonstrate what he could do having expired, and we being crowded for room, we had to remove it; but we gave those gentlemen who, in good faith, had advanced their money, a year longer to make further experiments, as it was supposed that there was merit in the process, and that if economy and good management could be secured in its operation, the practicability of manufacturing gas from petroleum could be demonstrated. They put up temporary wooden buildings, very imperfect in their character, for they were feeling their way, so to speak. They experimented for nearly a year, and, finally, got it to such a degree of perfection that we felt warranted in putting out our fires; and we did supply our town exclusively, for about ten months, with what is called petroleum gas, under the Lowe process.

Having been absent for a year or more, and having but recently returned, and the matter having gone very much out of my mind, I cannot attempt to state what the cost of the gas was ; but it was considerably less than the expense we had incurred by the old method. We furnished our town with the gas for a period of about ten months, when the wooden structure took fire and was consumed. We then immediately went back to the old process, and we are now furnishing our consumers with that gas. At the last semi-annual meeting of our board of directors, there was a resolution passed authorizing our engineer to put up two generators, by this method, at his leisure, and they are in process of construction.

There are a good many considerations to be taken into account in a plant situated as ours is, when we determined the adoption of one course or the other. Practically, there were a great many difficulties with us in its introduction. There was great obstruction of the burners. There was a lack of supply in the first stages, for a month or two ; but, one after another, these difficulties were overcome, and the result of the ten months, as I have stated, was a very considerable saving over the old method. I cannot state positively, but I think the cost was 54 cents per thousand feet, including labor and material necessary for production, in the holder. There was, I believe, an economy over the old method of between 80 and 90 cents. We are between wind and water, so to speak. We are between the supplies from tide-water, and from the west, and our coal costs us, perhaps, one dollar more than it would if we were on tide water. These matters of detail, however, I am not sufficiently familiar with to be able to state definitely the facts and figures which would be of interest to the Association. As I have stated, I am not an engineer. I have been, for many years, the commercial manager of our company, and I am not prepared to go into particulars in discussing questions of relative value, and the details which belong to the engineer's department.

Mr. Helme—It has occurred to me that perhaps this Lowe process has hardly had a fair showing. It has been rumored that they are about to put up some coal benches in the new

works at Baltimore, which looks as if they expected to abandon it. In explanation of that, one of the gentlemen who is largely interested, told me the other day that it was not owing to any want of faith in the success of the Lowe process, but that it was owing to a difficulty existing between Mr. Lowe and themselves, in regard to the royalty, the company supposing that they had secured the royalty by assignment, which Mr. Lowe and Mr. Stevens, I believe, dispute; and in order to put the matter in the position of a civil suit, an injunction was served upon them, and they determined to put up coal benches. I think it is nothing more than right and just that this question should be fairly treated, and that both sides should be considered.

On motion of Mr. Harbison, the thanks of the Association were tendered to Mr. Chambers for the paper read by him.

THE PRESIDENT—The next thing in order is a paper, by Mr. Charles H. Nettleton, on the subject of "Selling Gas."

MR. NETTLETON—A little over a week ago the secretary informed me that there would be few papers presented at this meeting, and asked me if I could not prepare a paper of some sort; and the paper I am about to read is the outcome of that request. The style, perhaps, is not so good as it might have been had I had more time in which to prepare the paper; but the ideas are about those I wish to express.

MR. NETTLETON then read the following paper on the subject of

SELLING GAS.

In this paper which I propose to present, I have departed somewhat from the usual course taken in the selection of subjects. I think all the papers which have been read before the Association have treated, in one form or another, of the manufacture of gas; and it is fitting and proper that it should be so, as we are an Association of gas engineers. But most of those present occupy also the position of managers, and to them, in that capacity, I would particularly address myself in this paper on the selling of gas.

Before proceeding with my subject I desire to state that the views advanced in this paper are the conclusions arrived at by

personal management of a small works in New England, and are not mere theories, having no local habitation except in the brain of the writer. That they do not apply to large, or even medium sized works, I am confident, but of their application in the working of a small works there is not the slightest doubt in my own mind.

I believe it is an admitted fact that gas companies, of all concerns dealing with the general public, are most cordially disliked. The reasons we assign for this are almost too well known to be repeated here. The inherent nature of the business, dealing with a commodity which has to be measured in a blind way, and which is not readily understood by a jealous public, makes our business a very difficult one in which to satisfy our customers. This we state broadly and repeatedly, and this, I think, most of us believe. But are we not deceiving ourselves when we say this? Is it not possible that we are ourselves to blame, in some measure, at least, for the distrust with which we are regarded, and for the dislike that many have for us? The mere witicisms that are so common—"You lie like a gas meter," "Don't ask that brother to pray, because he is the president of a gas company," and the like, to me show a state of feeling in the public mind for which we are largely to blame.

I am firmly convinced that the course pursued in selling gas, as it is generally practised, is radically wrong. If we gave the same time and thought to that which we give to the manufacturing of our gas, I believe where pennies are saved now, almost dollars could be saved then. In treating of the selling of gas, I would divide it into three parts: The means adopted to obtain new consumers; the treatment of them when obtained; and the introduction of appliances for the use of gas other than for illumination.

First, as to the means adopted to obtain new consumers. I hold it to be the duty of every gas manager to look for new customers as earnestly as he tries to reduce his leakage or increase his yield. A list of persons on the line of pipes who can afford to use gas, and who do not, should be prepared, and, if a possible thing, seen by the manager himself and asked

to become consumers. With some, a very slight urging will bring the desired result, with others the change can only be brought about by repeated and repeated visits. Often a man will hesitate because of the expense of piping his building; and this is not to be wondered at, when it is considered that in having such work done he has to employ a set of men whose name is almost synonymous with excessive charges and big bills. In that case the manager should name him a price at once, to include service, setting meter, and piping, and, if necessary to obtain the customer, do the work ten, fifteen, or twenty dollars less than cost. I know of no better way to invest either of those sums, if by so doing I can add one to the list of my consumers. It may be said such a course would make the service account a source of great expense. But would not great benefit be derived? What company could not afford to spend $1,000 or $2,000 for 100 consumers? The money would be back in the treasury in one or two years, and from that time the company would have the benefit of the extra consumption.

I have heard of a town in Michigan where the gas company runs the service and pipes into buildings at its own expense, and then furnishes fixtures at cost. I commend the action of that company to your careful consideration.

Again, where a consumer has left you and put up lamps, unless he be a poor, miserable fellow, it is good management to make repeated attempts to bring him back. Personally, I am never tired of asking those who have left me to come back to the true faith. But to do this successfully you must not let your consumer leave you at the end of a quarrel. By a little patience and perseverance you can almost always induce a customer in leaving to make some remark like this—that he is "sorry to give up the use of gas but he cannot afford it." That leaves the matter at a point where you can see him again on the slightest pretext, and ask him to use gas once more.

I hold that in doing this neither you nor the company you represent lose your dignity in the least. I regard the selling of gas like the sale of any other commodity. We make it and have it for sale, and if the people will not come to us and buy, is it not best to go to them and sell.

Less than two years ago the engineer of a large company in a city not a thousand miles from here, where the loss of consumers had been very great, made this remark to me, "There is a large number of people in our city who are anxious to give up oil and use gas again, and are only waiting to be asked; but we shall never ask them to come back. If they ever use gas again they must do so of their own free will."

Supposing any of the merchants of this city attempted to do their business on similar plans, how long a time could they keep their doors open? Or how long a time would a traveling agent retain his position if he, in selling, merely went to a city, sent out his cards, and waited for customers to call on him?

I am positive, gentlemen, that we make a mistake in doing a little or nothing to gain new consumers, or regain those we have lost. It is our good fortune that in ordinary time the number will increase without our aid; but how much faster would it increase if we only put the same push and energy into our business that others are obliged to put into theirs in order to live!

As to the treatment of consumers when obtained. A gas manager should always be polite in meeting his consumers, and never, no matter how great the provocation, lose his temper. Never too tired to explain how the bills in September are naturally larger than in August, or those in October larger than in September. Never in so much of a hurry but that he can show how a meter works, and never so impatient that he cannot listen to every complaint, and never so busy that he cannot attend to all the wants of his customers.

He naturally meets them oftener, when the bills are paid than at any other time. Do not receive the money as if it was conferring a favor on them to take it, but as if you knew it was a favor to your company that they paid it. A kind and pleasant word spoken then will often smooth away a frown, and your consumer, very likely, will go out of the office thinking the gas company is not such a bad institution after all.

But a man comes in bristling all over, and accuses you of selling poor gas, with oaths and adjectives thrown in not com-

plimentary to your company. The impulse with every one is to resent it; but what good will that do? If the accusation be true, own it up; explain how it happened, and your consumer is disarmed. If it be false, convince the man of his error, and not let it pass as trivial. Show a man once that he is mistaken, and he will be chary about saying impudent or impolite things a second time.

Again, a customer tells you he knows his meter is wrong, that all meters lie, and his is the worst of a bad lot. First, tell him his meter may be wrong—that it shall be tested—and invite him to be present when it is done; and then convince him of his error in regard to meters in general. Show him your glass meter, explain its workings, and my experience is, you will never hear from that man again.

I have seen on the walls of a gas company's office, in a neighboring city, a lithograph of a man being carried away on a stretcher, and labeled "The man who was talked to death." It was the habit of the office, as the clerk informed me, when a consumer commenced to scold about his bill, to point to that picture and say nothing. Gentlemen, supposing the case to be reversed, and you or I to be treated in such a manner, would we feel kindly toward that company? In my own case, much as I like gas, it would be sufficient to make me use oil.

Again, I believe it to be poor policy to tell a customer, "Pay your bill, or I will take your meter out," and then, perhaps, remove it, as I have heard of some companies doing, in the evening, or so late in the afternoon that the man had no opportunity of purchasing lamps. If you have decided that the man is no longer to be trusted, and that his supply of gas must be stopped, go and have a talk with him, and ask him if he had not better quit for his own sake, and if possible get him to agree to that. Then allow him to name his own time, within a day or two, when he will be ready with lamps. The man then feels he has been liberally dealt with, and often will make special efforts to pay his bill; or, if he uses oil, he tells his friends and neighbors that he cannot afford to use gas, and not that that " —— gas company" took out the meter.

Again, I believe it pays to be exceedingly liberal in collec-

tions. We all sell gas to a large number of poor men—men who really cannot afford to use it—and they often would consider it a great favor if a bill could go over for a month or two. Such concessions cost the company very little, and are of great moment to the persons to whom they are granted. Often, too, by being liberal in such a matter, a consumer will be retained, who would otherwise be lost. A risk is run, to be sure, of losing the bill, and with it one or two more. But I am satisfied, after trying the experiment for several years, that I have made more than I have lost by it.

To sum all up. In dealing with your consumers, be reasonable, conciliatory and generous.

Again, I believe the consumption can be largely increased by well directed efforts to have the gas used for other purposes than lighting. Most of us, I think, do favor gas stoves for cooking, and try to introduce them. I presume your experience has been similar to my own—that it is very difficult to sell the stove outright, owing to the expense. I worked on that plan for two or three years, and met with only partial success. During the past summer I offered to give the use of such stoves as I had free, if persons would use them for cooking. It was not long before all were out, and it is one of the best investments my company has ever made. I expect to continue to send out stoves, either in this way, or for a mere nominal rent.

In this connection, I would call your attention to the introduction of gas in factories or shops, where a small amount of heat is required, such as soldering, heating glue, metals and the like. Often, the manufacturer has never thought of using gas for this purpose, or, if he has, he does not know how to accomplish it, or he dreads the cost, or puts it off for more weighty matters. More than once I have had manufacturers in my town, who have tried the gas for some of these purposes, at my request, thank me for having called their attention to it.

Merely to show what can be accomplished in this line, and for no other reason, I will state that in three factories which I supply, there are in use fourteen stoves for soldering, and these will consume 250,000 feet in a year. All were put in at my solicitation, and but for that I am confident my company would

have gone without that consumption for years—perhaps never had it.

Again, by strong efforts I believe gas engines may be introduced. At all events, in my small town I have one running, a second erected, which will be running in two weeks, and very fair prospects of selling a third. Their advantages over steam in being a perfectly steady power up to the limit of their capacity, in freedom from all care and attention, with no danger of an explosion, ought to enable us all to bring them to the favorable attention of manufacturers for small powers. Their principal disadvantage is their cost, and I sincerely trust that the gentlemen who control their manufacture and sale in this country can be induced to lower the price, so that it will bear favorable comparison with the prices of steam engines.

Probably some of you may think my ideas visionary, vague, and impracticable. To answer this charge, if it be in your minds, and before it is uttered, I will give a few facts relating to my consumption. During the past two years, when I have been putting forth my strongest efforts in the ways I have indicated, my consumption has increased rapidly. In 1877 it exceeded that of 1876 by 32 per cent., and this year I think it will be 25 per cent. larger than last; and to this might be added the fact that electric lights have taken away almost 5 per cent. of the whole. A portion of this increase is due, I am satisfied, to the endeavors I have put forth to extend the use of gas.

Given a small town, where it is possible for the manager to know personally almost every consumer, and let a plan similar to the one I have indicted, be carried out, I feel confident that the use of gas will be largely extended; that when once obtained, the consumers would remain; that the bad feeling, if it exists at all, would almost entirely disappear; and instead of being a hated monopoly, the gas company would become one of the most popular institutions of the place.

On motion of Capt. Wm. H. White, the thanks of the Association were tendered to Mr. Nettleton for the paper read.

MR. HARBISON—I would like to ask Mr. Nettleton whether he is willing to make the statement here that he made before the New England Association, in regard to the use of the electric light in his town?

Mr. Nettleton—Certainly, if the Association wishes me to do so; but I thought electric light would be so much talked about that the Association would not care to hear anything upon that subject at this time.

Mr. Neal—The gentleman stated that five per cent. of his consumption had been lessened by the introduction of the light.

Mr. Nettleton—The electric light originated in the United States, in the town in which I reside, with a firm known as Wallace & Sons. They have been working at it for several years, and have at last succeeded in producing a very good machine, and a candle for furnishing the light, which is, I think, equal, if not superior, to anything in the world. If you have noticed the accounts published in the English *Gas Light Journal* of the doings upon the other side, I think you will have observed that wherever they have used the light, a wire has been run from the machine to the candle, and then back to the machine again. Two, three, and four candles are treated in a similar manner. These men have succeeded in perfecting the candle, so that all they have to do now is merely to run a wire around their shop, and connect with it any number of candles they desire. In their own shops they have been exceedingly busy for the past two years, and have been obliged to run a large portion of their works for twenty-four hours; and most of the places where the men have been employed have been lighted by these electric lights. If they had been obliged to use gas, you can readily see they would have had a very large bill. Another fact I ask you to observe is, they still remain our largest customers, or about the largest. Another fact that I mention in this connection is, that they use the light exclusively where the coarse work is done. They use it in the model room, and in other portions of the building where coarse work is done, but in every place where they do anything like fine work they have to use gas. They tell me that, in their opinion, gas can never be supplanted by electric light where fine work has to be done. At all events, they are large stockholders in our company, which is certainly a very good argument in favor of what I have just stated; and besides that, I have a standing offer from them to buy more of our stock, at a certain price, if I can get it.

Another place where the electric light is used, is in a large foundry. They have been excessively busy there for the last two years, and have been obliged to keep a set of hands running twenty-four hours. They have been using from three to eight electric lights. You can readily see, therefore, what effect the use of the electric light in these two places, has had upon our consumption in that direction.

There is still another fact that I will mention, and that is, that Mr. William Wallace, of the firm of Wallace & Sons, who has perfected this candle, as well as a machine for generating electricity, will be present at the lecture to-night, and if any gentlemen wish me to do so, I will be very happy to introduce them to him. You will find him a very pleasant gentleman, and if any of you have fears that electric light will supplant gas light, I think you can quiet your apprehensions on that point,

MR. NEAL—Before we adjourn, I would suggest that if any gentlemen wish to visit the works of the Municipal Gas Light Company, it perhaps be best for them to go now.

THE PRESIDENT—I will add that you will be received with the utmost courtesy and attention, and you will be furnished with all the information that you may desire, and which they are possessed of. I will also state that there is a gas engine in the gas works at the foot of Eighteenth street. I have never seen it, but it is there, and I shall be happy to have any one of you, or the whole of you, call and see it. You need no card from me. The works are always open, and I have sent word that some of you may come, and you will find some one to show you the engine and around the works. You will pardon me if I do not go with you, for I am very ill to-day ; and besides that, I have several duties to perform which will prevent me from going to the lecture, and which will keep me busy until past midnight. I have also been requested to say that the room in which Prof. Morton is to deliver his lecture will accommodate about four hundred people, and that he will be glad to have you come and bring your wives, if you have any, and if not, your sweethearts, and New York can furnish as many of those as you desire. [Laughter.]

The Association then adjourned until 2 P. M.

AFTERNOON SESSION.

The Association met at 2 P. M., and was called to order by Mr. Price.

The next paper to be read is one prepared by Mr. McIlhenny, but I believe he is not in the room.

MR. CARTWRIGHT—I think a number of gentlemen are just coming from lunch, and think it would be well to defer the reading of the paper until they are here.

MR. PRICE—There are a number of interesting questions growing out of the paper which Mr. Nettleton has just read, and I think the time would be very properly taken up in discussing them. For instance, he speaks of a gas engine that he has introduced, and says that it is an expensive engine. I would like to know what it costs, and what it costs per horse-power to run it. There are several questions growing out of this paper that I would like to have answered, and as he is not in the room, perhaps there may be some gentleman present who can give the information.

MR. SHERMAN—I have seen the engine he refers to. I believe it is a four horse-power engine, and that its cost was, if I remember rightly, $800.

MR. COGGSHALL—Mr. Nettleton informed me that the engine which was run by Mr. Wallace is a two horse-power engine, and that it cost $476. They have run at intervals of perhaps an hour, or two hours, from eight to ten hours a day. The engine which is now setting up, I think, is to be a four horse-power engine, and is to be run ten hours a day. He can give you a better estimate of the cost than I am able to do. He charges them $2.50 for the gas to run it. Mr. Wallace informed him that the cost of running the machine was not so much as he expected it would be: and that it was really a cheaper motive power than he expected to have.

In regard to the gas stoves, that he speaks of in his paper, I think he sells a Providence stove, called "The Retort Gas Stove," which I am endeavoring to introduce myself in Fitchburg. I let them out at a small rental, and set them up, and take them away for the season. I introduced from 25 to 50 of

them. I sent out circulars, as well as using my own efforts. The makers of the retort stove claim that one-eight inch would be sufficient pressure. I give them a pressure of an inch and a half, during certain hours, which gives a very satisfactory heat. Of course, ladies ironing during the day make some complaint that the pressure is not enough. I give an inch pressure, from eight o'clock until half-past eleven, and from half-past eleven until half past one o'clock, I give them an inch and half pressure, and we have no trouble in operating the stove to advantage.

MR. PRICE—I have one of the same stoves in my kitchen. That runs very satisfactorily indeed with nine-tenths pressure. I am three miles from the works, but I have heard no complaint in regard to the pressure not being sufficient. I am not, however, at all sure that it is the best stove; and if any one has any information on that point I would like to have him furnish it.

MR. CARTWRIGHT—How much does it consume per hour?

MR. PRICE—I am not able to say; but I should think, very likely, about seven feet.

MR. COGGSHALL—I have used a stove, in my own house, called the "Metropolitan Gas Stove;" and it has given exceedingly good satisfaction. We use it in the winter for broiling steak, or for broiling anything, for the reason that we can get such an intense heat that we consider it is very much nicer. The stove burns about fifteen feet per hour. We have two places for cooking, and they are both going at the same time frequently. We use about an inch, or an inch and a quarter pressure. One objection is the stopping up of the little orifice of the burner, and occasionally we have to clean that out; after we have done so it works very nicely. I have sold quite a number of the other stoves, and I have got one of them also. I have got two gas stoves at my house, and they afford all the cooking facilities required in the way of broiling meats.

MR. CARTWRIGHT—In using your stoves do you employ any means for taking off the products of combustion?

MR. COGGSHALL—I have mine set in a back room, where it

does not trouble us at all. If we had it in the kitchen it would trouble us, perhaps, when meat was broiling; but it would not be from the fumes of the gas, because there are none.

Mr. Cartwright—You took no means for carrying off the product of combustion?

Mr. Coggshall—No, sir; I would state that near the works which are running in Brooklyn, a man has established a factory for frying potatoes, and supplying the hotels and restaurants of Coney Island and Brooklyn, and he also ships them to other places, I believe. These are fried in lard; and the proprietor says that, by using gas under one set of pans, and coke under the other, he saves from 20 to 30 pounds of lard to the pan. That fact is attributable to the more even heating of the lard by the gas.

Mr. A. C. Wood—Mr. President: I have had a short experience with a gas cooking stove; and as I arrived at the actual cost of using it, my experience may be of interest to the members of the Association.

In July last I set up in my kitchen one single and one double atmospheric-burner gas stove, attaching a meter to the same. With these two stoves was done all the cooking, baking, ironing, and necessary kitchen work, except washing, for our family of seven, some portion of the time nine; and for 45 days the consumption of gas was 1,600 cubic feet, which, at $2.75 per 1,000 (about the average price of gas) the cost was $4.40, or 9¾ cents per day. For summer use, certainly, it is the cheapest fuel that can be used.

Mr. Price—I understand the gentleman who introduced the gas engine is in the room; and before Mr. McIlhenny reads his paper, I think it would be interesting to hear something about the engine, and perhaps Mr. Schleicher will tell us something about its cost, and the cost of running it.

Mr. Schleicher—I will state to the gentlemen of the Association that we have one of our machines on exhibition at the Manhattan Gas Company's works, and it can be seen in operation there. The gas consumed by this engine, according to the experiments made in England and in Germany, is about 21½

cubic feet per horse-power, per hour. The cost of running varies according to the price of gas in different cities. In some cities gas is very low; for instance, in Pittsburgh, where gas is \$1 per 1,000, the cost of running an engine there is about 4½ cents per horse-power, per hour, which is generally cheaper than a steam engine, taking all expenses together. Taking the matter of fuel alone, it would cost generally a little more to run it than to run a steam engine, but taking into consideration the attendance required for a steam engine, the amount of trouble and time it takes to keep them supplied with coal, to clean out the ashes and dirt, the water, rent, etc., the cost of running the gas engine will generally be found to be cheaper than the cost of running the steam engine. The cost of running the engines which we have in this country will be ordinarily about 4½ cents per horse-power, per hour; but we expect to make them more economical in this respect, and we hope, bye and bye, to give a very respectable consumption to the gas works through our engines. In Europe we have been selling them to quite an extent. Of course, we have there the advantage of restrictions against the steam engine. A steam engine cannot be put in a building where there are tenants living, and parties often have a good deal of trouble about putting a steam engine up, and they take a gas engine. One objection that was made to the engine we had at the Centennial Exhibition was on account of the noise, but the present one is of much better construction. The German makers and the English makers have entirely discarded the old engine, and are making the new one. In one small place in Germany there is a manufactory where there are three hundred hands employed, and where they make gas engines exclusively. We have started in Philadelphia only recently, for the gas engine is a comparatively recent invention. We have been turning out some engines that we have set up in Philadelphia, and we have sent some to the New England States. We have put up one in Massachusetts recently. We are finding a slow sale for it because of the high price of gas. There are several gentlemen connected with gas companies in Europe who have already proposed to us to reduce the price, as the use of our engines will find employment for the pipes during the day time, when they are generally idle. Besides, as

they are used during the summer as well as during the winter, the consumption will be steady, and the pipes will thus be constantly utilized by a large quantity of gas passing through them. The percentage that is charged for the cost of distribution will decrease in proportion to the quantity of gas that goes through the pipes. We believe that by the use of our machine, the utilization of gas as a fuel can be made practicable. We have been making these gas engines over in Europe for some time of large sizes, and have started to make them here now, but we didn't think it prudent to begin with the largest sizes first. We sell them from $400 to $750, according to the size. The price is not materially different from a good steam engine of the same size.

MR. LITTLEHALES—What pressure would be required to run the engine?

MR. SCHLEICHER—They generally run better without any pressure at all; or, at least, very little pressure.

MR. LITTLEHALES—We had one in our works for about eighteen months, and it was an intolerable nuisance, for the simple reason that at the ordinary pressure it would not run; and in keeping up a higher pressure to supply this engine, we lost a dozen times more than the consumption of the gas amounted to. It seems to me very important that an engine should be able to work at low pressure.

MR. SCHLEICHER—They require a certain pressure, of course; but the pressure with our machines is of very little importance. As a general thing, a little pressure is better than a high pressure. In Philadelphia, the pressure, I believe, is from two to five inches. We have no alterations to make; it always goes along nicely and smoothly.

MR. LITTLEHALES—Would it work at a pressure of eight-enths?

MR. SCHLEICHER—I believe it would. As I said, a little essure is considered better than a high pressure. But if it uld not work at that pressure, we could easily insert a prese regulator.

IR. LITTLEHALES—Do you consider that a pressure of eight-hs is sufficient?

Mr. Schleicher—Yes, sir, I do.

Mr. Littlehales—Do you think half an inch would be sufficient?

Mr. Schleicher—Yes, sir; we only require a certain amount, and that is very low; and we only require a certain sized pipe to have the quantity necessary.

Mr. Cartwright—Of course a machine of this character is to be measured by comparison with a steam engine of the same power. I would like to ask the gentleman why it is he considers the cost of this engine to be less than the cost of a steam engine of equal power. Is it in the workmanship.

Mr. Schleicher—Yes, sir; it is of different workmanship. It is a finer class of work than that required on a steam engine. Steam engines can be made of almost any quality. You can get them from $100 up to $300, for one-horse power; but our engine, to work successfully, must be made very exactly, and very fine.

Mr. Cartwright—You don't mean to assert that the workmanship of the gas engine, is superior to what is necessary for a steam engine, do you?

Mr. Schleicher—Yes, sir, it is.

Mr. Cartwright—In what respect?

Mr. Schleicher—In many respects. The openings of our valves must be made very exactly, or the engine will not work. If there is the slightest irregularity or defect, the efficiency of the engine is destroyed, and it becomes necessary to guard against them with the utmost care. All the functions of the engine must be performed at precisely the right time, and in the proper proportion; and therefore it is necessary that the machine should be constructed in the most careful and exact manner possible.

Mr. Cartwright—Are not all these things necessary in a well constructed steam engine?

Mr. Schleicher—They are, in a well-constructed steam engine, and that is the reason why such steam engines are selling at the same price as our engines. Where the same amount of care is bestowed upon the construction of a steam engine,

they will be quite as expensive as ours; but there are a great many steam engines put on the market to sell that are by no means well or carefully constructed. Such engines can, of course, be bought cheaper than our engines can, because, although every part of such a steam engine does not work perfectly—that is, is not finished in the most exact manner—yet they do their work and answer the purpose for which they are employed. But in our engine, unless every part works with the utmost nicety, the machine will not operate at all. Every function, however minute, must be performed with perfect regularity, at precisely the right moment of time. We have to put the highest class of work on our engines. Besides that, we have very much larger cylinders, and very much larger pistons, for the same power, than a steam engine.

MR. CARTWRIGHT—I can readily see how that would add to the cost. Because, of course, the larger the piston the greater the expense. But I am very unwilling to admit that there is any more, or any better, work required on a gas engine than there is on a properly constructed steam engine.

MR. SCHLEICHER—We build engines in large quantities in England as well as in Germany. In our German works there are about 300 engines made at once. They have special departments or factories for special parts; and although the cost of construction is very low, still, the prices even then are higher than the price of ordinary steam engines.

MR. CARTWRIGHT—I do not wish to interpose any objection, of course, to the gas engine, because, if a proper engine could be introduced, it would be a benefit to the gas companies. But if an engine is to be introduced of excessive cost, either by reason of the extra workmanship upon it or the royalty that must be paid, of course that places an embargo upon it at once.

MR. SCHLEICHER—We have already started the prices lower han they are at present in England, although the wages that 'e pay are from 35 to 40 per cent. higher than they are in)reigh countries.

MR. CARTWRIGHT—All that does not lessen the cost in comrison with the steam engine, and the work done with the

steam engine. Take, for instance, the Baxter engine. The manufacturers of that engine probably have as perfect a system for making the different parts of the engine interchangeably as any other concern in the world, not even excepting Germany or England. But still we find that an engine of a certain horse-power (take the Baxter for an illustration, where the workmanship, if not equal to that of the gas engine, is certainly very little inferior to it), is yet cheaper than a gas engine of the same power.

MR. SCHLEICHER—We are at present selling our engines cheaper than the Baxter.

MR. CARTWRIGHT—Perhaps there is an excessive royalty upon the engines; if so, of course that would make a very great difference in the cost.

MR. SCHLEICHER—The royalty is not excessive. I again repeat that our prices are lower than the Baxter engines.

MR. CARTWRIGHT—Of equal power?

MR. SCHLEICHER—Yes; but there are at present a great many second-hand engines in the market, and of course those can be bought cheaper. Our two-horse power engines are $400; and Baxter's two-horse power engines are $400; our four-horse power engines are $550, and Baxter's four-horse power engines $600; our seven-horse power engines are $750, and Baxter sells his six-horse power engines at $800. These prices are of course subject to some discount, but that is a matter of arrangement between the purchaser and the seller.

MR. MCILHENNY—Before reading the paper that I have prepared, I would like to offer a resolution; and before offering it I desire to make an explanation. It appears there is a provision in our Constitution prohibiting the Association from accepting any courtesies or hospitalities. It is either a provision of the Constitution or a resolution passed to that effect. I was not at the meeting when the resolution was passed, or I certainly would have had something to say against it. It now appears that we are likely to leave New York without having an opportunity of meeting each other socially, and the nice sensibility of the members, in compliance with the resolution, is not likely to let us have that pleasure. I think this gather-

ing should not be permitted to end without having something of that kind, as has been the custom in nearly every place in which we have heretofore met. I think we ought to pass a resolution that we will meet to-morrow, say at four o'clock, and have a dinner and a sociable talk together. Captain Dresser and I inquired at the hotel, this morning, to ascertain the terms upon which a dinner could be furnished. A first-class dinner, gotten up entirely independent of the guests of the hotel, can be furnished for $6 a head; but the gentleman stated that he would furnish an ordinary dinner to all those who are stopping at the house, exclusive of wine, of course, and all those who were not stopping at the house would be charged $1.75 each, which is the ordinary price of a dinner at the Fifth Avenue Hotel. I want to get the sense of the Association on that point. It seems to me we ought to have some opportunity of meeting socially, and it appears we shall not have an opportunity, except we make provision for it ourselves. It has been the custom, ever since this Association has met, to have something of the kind, and I hope we shall not leave this metropolis of the country without having the privilege of meeting each other in some such way. I move, therefore, that the members of the Association form themselves into a dinner party to-morrow, at four o'clock, and pay the expenses themselves.

MR. NEAL—It would be very pleasant to members to dine together, even if they partook of an ordinary dinner; and after dinner there might be a good deal of friendly feeling and sentiment exchanged. I have no doubt we should all enjoy ourselves very heartily. I am in favor of the resolution. I think the proper time for the dinner to have taken place would have been this evening, if it had not been for the lecture that we are to listen to from Prof. Morton. I fear that by to-morrow evening many of our members will have left the city. I do not think that our session will be protracted beyond to-morrow, at twelve o'clock; and for that reason, am afraid that many of our members will not be present. Those who remain, however, can have a very pleasant time; but I think it is very important to have as large a gathering as possible. And I

hope we will get an expression from the members as to their intentions, whether they propose to remain, so as to attend the dinner at four o'clock to-morrow, or whether they will be obliged to leave for home. I, therefore, would suggest that we put it to a vote, in an informal manner, in order to see what the sense of the Association is.

MR. STANLEY—I move to amend the resolution of Mr. McIlhenny, by making the hour two o'clock instead of four.

MR. MCILHENNY—I accept the amendment.

MR. HARBISON—There are a few gentlemen present who cannot eat dinner in an hour, particularly when they have nothing to wash their dinner down with. It takes longer to eat dinner under these circumstances, and I think if the gentlemen sit down to dinner at two o'clock, they will not get through in time to take the three o'clock train for home.

A MEMBER—That depends upon the length of the neck. [Laughter.]

CAPT. W. H. WHITE—It is eminently fitting and proper, it seems to me, that we should have some pleasant social gathering of this kind when we meet. We always do so, except when we come to New York City. The resolutions adopted by the Executive Committee, were wisely adopted, I suppose; but this little dinner, gotten up in an informal manner, by every member paying for his own dinner, and by those desiring to drink wine, paying for their own wine, is certainly independent and strictly upon democratic principles. After we have eaten dinner we can have a social talk together, and there will still be ample time for members to get from the hotel to the trains. There are horse cars and stages to take you to the depots, and there is the elevated railroad to take you, if you are not sufficiently elevated yourselves to get there, down to the five o'clock boat. It seems to me when we meet every year, we should have a real social, pleasant time together. This has been the custom with the New England Association for years. The most pleasant part of our meeting together there, is the social little banquet we have there sometime during the session. It is so, also, with our foreign brethren. Both the French and English Associations never think of meeting without having a dinner,

It cultivates a spirit of kindly feeling between the members, which is one of the purposes of our Association; and I think we should, by all means, have this little gathering. For my part, I heartily endorse the resolution, and hope that it will pass.

MR. CORNELL—If it is desirable to get through with the dinner earlier, so that members may take the afternoon trains for their homes, let the hour be fixed at one o'clock.

CAPT. W. H. WHITE—I would suggest that the regular hour for dining at the Fifth Avenue Hotel is two o'clock, and the proprietor would much prefer to give us our dinner at the regular dinner hour. The hotel desires to give those who are boarders their dinner without extra charge; and, of course, they prefer to do so at the regular hour.

MR. PRICE—I will take the responsibility of asking how many of the gentlemen present can make it convenient to be at the hotel to-morrow at two o'clock?

Nearly all of the members in the room signified their intention of being present.

MR. HELME—I would suggest, that as we are not going to have but one session to-morrow, we prolong the morning session until after twelve o'clock, say, until one. That would give us an hour to get ready for dinner. If we sit down promptly at two o'clock, we will get through in ample time, for those who wish to do so, to leave for home.

MR. PRICE—I would like very much, personally, to have something like unanimity in this matter. I attended a banquet at the New England meeting, two years ago, and I enjoyed it very much. The one in Washington was also very enjoyable. I like the suggestion of having a dinner to-morrow; but if we do, I hope it will be pretty unanimously attended. It would not be very gratifying to have but 20 or 25 members present; but if nearly all the members can attend, I hope the resolution will be adopted.

The resolution, as amended, was adopted.

MR. HELME—I would suggest, that some hour and place be fixed, when gentlemen who intend to be present, will give their names.

A Member—I move that a committee be appointed, consisting of Capt. White, Mr. Helme and Capt. Dresser, to take this matter in charge. Carried.

Mr. McIlhenny then read a paper on the government of gas works, as follows:

THE GOVERNMENT OF GAS WORKS.

The subject on which I propose to offer a few remarks is, "The Government of a Gas Works, or How a Gas Company should be Governed."

In the management of all undertakings, organization is of the first importance, and in no kind of business or manufactory is this of more importance than in the production and sale of illuminating gas.

You will observe that in the manufacture and sale of gas there is, perhaps, a more close and intimate relation than in almost any other kind of traffic, because the great difference between the amount made and that sold involves so large a moneyed consideration. Again, the character of the business is unlike almost any other in the variety of knowledge necessary to secure successful management, there being mechanical and chemical knowledge required—business and executive ability necessary. In view, then, of the great value of proper organization to a business of this kind, it is proper here to remark that there is, perhaps, no interest involving so much pecuniary consideration, where there is a greater variety of organization, or less concert, as it is but seldom found that two companies are working in the same way. While circumstances may require some difference in the management, there is no excuse for the great difference in the method of conducting this business (if any system can, or ought to be, taken as a standard), and that there should be some rule regulating this, as in all other important matters, is manifest.

Companies are usually organized with a board of directors as the governing power, and they, in turn, elect one of their number as president, a secretary, and sometimes a superintendent, but frequently this officer is appointed by the president. The board of directors can have but little to do with the detail

management, and, of necessity, look to their officers for the performance of all necessary duties. The president, being the head of the company, is properly and rightfully the ranking officer; and in the selection of a man to fill this important position, the greatest care should be exercised, in order to secure one who combines all the qualities required, and these I assume to be, first of all, good common sense, active business energy, a knowledge of banking and finance, a man generally well informed, and, of course, a gentleman. If you can combine these qualities with social and financial standing, mechanical and engineering, or chemical knowledge, you have a man eminently fitted for the place.

The secretary is also an important officer, and the choice of this man should be made with great care. He should be a man with uniform urbanity of manner, good and courteous address, intelligent, popular with the public, and familiar with the social and financial standing of the consumers, a man acquainted with general business matters, energetic and honest, with executive ability. Of course it is much easier to describe these qualities than to find them ; but we are now trying to fix a standard.

The superintendent—and this I assume to be the proper title for a manager of a gas works—that of engineer, so commonly applied to the holder of this position, is frequently erroneous, because, in many instances, managers have but little knowledge of engineering, and when that quality is required, some other person is called upon to supply it. I claim, moreover, that superintendent is a title of more dignity and propriety than engineer; but when the manager acts in the capacity of both, then his title should be engineer and superintendent.

The qualifications of a superintendent should be mental and physical vigor—both are indispensable. He should have a comparatively extensive knowledge of the several branches of science relating to his business. He should be a good mechanical engineer, understanding and having a knowledge of both rough and fine work ; and if he were a practical mechanic, machinist or millwright, it would be to his advantage. He requires a knowledge of building in stone, wood, and iron work. He must, of course, understand how to construct every part of

his works ; and, if necessary, ought to be able to do it himself. He ought to know how to manipulate his material for the production of crude gas, and when he has done this he must be familiar with the means of condensing and purifying it. He ought to have the faculty of managing men, and should have much force or executive capacity. Because of his intercourse and dealings with the public and corporate bodies, he should be a man of good address and agreeable manners, and understand well the relationship of his company to the public, in order to best protect its interests. His intelligence and position, as executive officer of an important institution in the city or town in which he lives, should enable him to secure and retain a first-class social standing; this is desirable in every man's case, and it is particularly so in that of the manager of a gas works.

Having endeavored to describe the qualities that should be possessed by the principal officers, I now propose to define their respective duties. First we will refer to the president, who, when he is placed in this high and responsible position by the owners, is expected by them to guard well their interests; and under the influences by which those gentlemen are frequently elected, the necessity of proper organization is apparent. We are all aware that men are as often chosen to fill this important place for expediency as for special qualifications, and in many cases are chosen from business circles without any previous training, or mechanical or engineering skill. I do not say that this is not sometimes right, and the best selection is doubtless made that can be made by a board of directors who are looking for results and dividends by means of some astute manipulations, and frequently, as in all kinds of business, the right man is selected ; and the company is to be congratulated that makes this lucky choice, because so much depends on him. The duties of the president, I claim to be a general supervision of the entire affairs of the company, without any special detail to perform himself; and in the division of this work he ought to have but two responsible heads, the secretary and the superintendent. To the first belongs everything relating to gas after it leaves the burner—such as the control of every man, clerk meter-taker, and other persons in his office, keeping all ac-

counts, collecting all moneys, and looking strictly after the correct registration of the meters, by requiring his assistants to make careful comparisons, and report any apparent defects.

His office should be conducted on the best, simplest, and yet most comprehensive system ; and it is of great importance that some uniform method should be adopted and applied to this important branch of the business.

In order to ascertain the best system for the conduct of this branch of the business, the president and secretary should examine the methods of other companies, visit other cities, and get a personal knowledge of the workings and systems in use, and should adopt whatever of their methods would be suitable and useful to them. It would, perhaps, be difficult to establish an exact rule to apply to the manner of conducting the business of the secretary's office, as circumstances will probably require some difference in nearly every place, and it is not absolutely necessary in this case, so that an efficient and comprehensive system be adopted.

It is in the execution of the duties that the effort should be made. The secretary should, as has been said, have control of all the details after the gas leaves the burner, and for the performance of these duties the president should look to him. Neither the president nor any other person should interfere in the details by giving orders independent of the chief officer, because such conduct always tends to lesson discipline and create confusion. The president and directors should enforce their rules through the proper officers.

The custody of the money should be intrusted to a treasurer, who will give the necessary bond. All moneys should be paid over to him by the clerks or collectors, as the case may be, and a receipt given by him to each man whenever payment is made. A receipt book for this purpose should be provided. The treasurer's accounts ought to corresnond with the amount of gas sold, less the delinquent bills. A bank, or, banks should be designated by the board of directors, in which he shall deposit the money ; and when this is done, and proper returns made to the secretary, his responsibility ceases.

All payments should be made by checks drawn by the secre-

tary and countersigned by the president, and all bills for which checks are given should be approved by the proper officer—by the secretary when contracted for his department, and by the superintendent when belonging to his department; and no payments should be made except upon properly certified vouchers.

The success of the company will depend largely upon what is known as results, which means chiefly the manufacture and sale of gas; and the management in this direction will be a guarantee for either success or failure. Indeed, it may be said that the very existence of the company depends on this. Hence the great necessity for having the very best management in this department that can be obtained. And there has, perhaps, never been a time in the history of the business when the necessity for this has been more apparent than now, because of the tendency for cheaper gas, and rivalry of other lights.

I have previously stated, in defining the duties of the secretary, that he should have charge of everything after the gas has left the burner; and now, in defining the duties of the superintendent, I claim that he should have charge of the gas before it leaves the burner, which covers all the details of manufacture and distribution.

He should employ and discharge every man in his department; his authority to purchase will depend largely on the confidence of his company in his judgment and ideas of economy. He should have control of the manufacture and distribution, and be responsible for both.

Coal purchased should be paid for by the weight received at the works, and all coal sent into the retort house should be accurately weighed and the account proved once a year, by working out the coal received, or obtaining, by exact measurement, the weight of that on hand. That is—the coal account should balance at the end of the year.

It is obvious that the great effort should be, to sell the maximum amount of gas, of proper quality, to the ton of coal; and to secure this end, it is of the utmost importance that the manufacture and distribution be under the control of one man because, when more than one is managing it, there is a divided

responsibility, and there cannot be other than confusion of council, and conflict of opinion, if not of authority. Two captains cannot sail the same ship, nor two men manage a gas works. There must be a head, which will have the authority and responsibility.

The most important part of the superintendent's duties is at the works; here is where the most of the money is either lost or made, and to this part of his business he should bend the principal portion of his ability and energy. The works should be his headquarters, and there, nearly all his time, should be spent, even if he has nothing particular to do, his presence is needed to influence others, and it is highly important that he should have a personal knowledge of everything that transpires; to have this, he must see it. It is a mistake, which is often made, to suppose that a gas works can be managed successfully from an uptown office, or by telephone; nothing but the strictest personal attention will secure the best results, nor can chance be relied on to produce these, they come not in this way, but are the result of study by day and night. Indeed, the intelligent and thoughtful superintendent never loses sight of his business, his mind is always active, and no opportunity is allowed to pass where he can improve his company's condition.

The necessary power and authority being placed in his hands, his responsibility is, of course, in proportion; and having obtained the power he requires from the president or directors, it then becomes a serious question what they shall expect of him. What they have a right to expect and demand is, in the first place, the very best general management. As to results, there should be no excuse offered; nor any accepted, for failure; on the contrary, I am of the opinion that a standard of results ought to be established by each company, such as gas sold, make per man and retort, and cost delivered to the consumer. This can easily be done, by taking the best results of other companies, and requiring the superintendent to equal them, because there is no reason why as good results cannot be made in one place, as in another, where the same, or as good material is used; if there are difficulties, he should overcome them, except, perhaps, those of a climatic nature. I believe this the best method of bringing about the best results.

As the president has but one man to look to, and if he, the president, knows what is required, and the superintendent fails to fulfill the standard, he must admit his failure, and might realize that he has missed his calling. It cannot be other than gratifying to a superintendent, to know that his results are among the best, for they are his stock in trade, his capital; and it is equally as much to his interest, as to that of his company, that they should be the best, because they never fail to be appreciated.

In this, as in all other callings and professions, there are some men who have superior capacity, and it cannot be expected that a superintendent can acquire all necessary knowledge at home, or in the city in which he lives. This would be unreasonable; therefore the company should afford him every opportunity for obtaining information, by sending him to other cities in this country, and it would be to his advantage, if he were permitted to investigate works in foreign countries. He may get but few ideas, but he is certain to learn something that will be useful in his business, and it will take but very little in this respect to fully compensate his employers for the small expense incurred. Aside from the advantages secured by general information, anything that facilitates the acquirement of knowledge on his part, is sure to redound to the benefit of his employers.

It becomes a question, how men possessing this merit in the gas profession should be compensated, because it is clear to me that they should share in the emoluments that their abilities have secured for others. This principle is recognized in nearly every vocation in life. A successful statesman, soldier, or patriot, is rewarded by his grateful country; the lawyer, doctor, and mechanic, who possess superior abilities in their various occupations, are generally rewarded by their large fees and extensive business; and in the mercantile line, men possessing ability or influence—which in that business amounts to the same thing—are taken into partnership, or in some way recognized.

In the gas profession, however, no opportunity is given the manager to share in the profits, no matter what his success may

be, except by his compensation in salary. This sometimes is liberal, but often otherwise. It is but seldom that the superintendent owns much of his company's stock, and he generally remains so poor that no matter what may be the prospective or actual profits, he can get none of it.

Now, in view of these facts, it seems to me that there ought to be some rule or custom established allowing a certain percentage of the value of results, after they reach a certain limit, to go to the superintendent; and while this would be only simple justice, it would stimulate men to make extraordinary efforts, and the man who failed to accomplish something under such circumstances might be truly pronounced a failure.

The organization, then, will be as follows:

The superintendent to have charge of everything until the gas leaves the burner, and the secretary to have charge of everything connected with his office after the gas leaves the burner —both to be responsible to the president, and neither to interfere with the duties of the other.

If either fails to meet the requirements demanded by his office, the president has but to show this, and hold each to a strict accountability.

Of course the performance of these duties will depend largely upon the capacity of the president to determine when they are properly executed, as he ought not to accept less than agreed upon, or expect more.

On motion, a vote of thanks was tendered to Mr. McIlhenny.

MR. CARTWRIGHT—There seems to be some misunderstanding in regard to the phrase used by Mr. McIlhenny, in the paper which he has just read, and it may, perhaps, be well to have it explained. He spoke of the control of the several officers which he has named, ending with the burner. I think it would be a little more satisfactory if he would make that expression a little more explicit. Does he mean that the control ceases at the end of the burner, or when the gas leaves the burner?

MR. MCILHENNY—The language used is that the secretary should have charge of everything after the gas leaves the bur-

ner, which includes all the bills, and that the superintendent should have charge of everything before the gas leaves the burner, which includes everything up to the time the bills are made—meters, street mains, the works, and all the details incident to the production and distribution of the gas.

MR. LITTLEHALES—I presume it does not come within the scope of the secretary to trace the gas from the burners. I suppose his duty ends at the meter rather than at the burner. I presume that those who copied the paper did not copy it right, and the term "meter" should occur where the term "burner" occurs.

A MEMBER—The presumption is that there is no loss between the meter and burner.

MR. MCILHENNY—Bills, of course, are made out at the meter; but the consumer knows nothing about the gas until it reaches the burner. That is the proper point of designation between the time it leaves the holder, and the time it is registered on the bills, or on the meter, which is the same thing. I make the burner the dividing line between the duties of the two officers, the superintendent and the secretary. Of course I am not laying this down as a rule. I do not suppose there are many who will follow it; but it seems to me that, in order to simplify these things, and in order to get the best results, it is necessary to divide the responsibility in some way; and I have done it by making the secretary responsible after the gas is registered, and the superintendent responsible before it is registered.

MR. HERZOG—There is one thing to which Mr. McIlhenny refers and which he desires should be introduced here, that has been put into successful operation in the large Continental gas companies, and that is giving the superintendent a share in the profits to a certain extent. Some of these large companies pay their superintendents a small salary, and, at the same time, give them a percentage of their earnings. I believe that is the just and fair way for the companies to do, and it has worked very successfully there. In one place in Germany they have about 15 or 18 gas works, and they give their superintendent a certain portion of the net earnings of the company; and the

talents and ability of the superintendent contribute to the prosperity of the concern.

MR. NEAL—I really do not think some of the members understand what Mr. McIlhenny means by the secretary to have charge of the gas after it passes the burner. I do not think that is exactly what he means, because, after the gas passes the burner or the meter, what control has the secretary over it? He has sold it, and it passes out of his hands. I apprehend that he means this: that the secretary is to have control of the meter after the gas passes it. After the gas passes the meter I do not see how he has any control over it.

MR. MCILHENNY—What I said was that the secretary should have control of everything after the gas leaves the burner.

MR. NEAL—What is everything?

MR. MCILHENNY—All the details.

MR. NEAL—The gas has passed the meter and burner, and now everything, as Mr. McIlhenny says, is in charge of the secretary. He makes out the bills, he collects the bills from the consumers, and the money is paid over to the treasurer. So it seems that the secretary does not have control of quite everything. I think the money that is paid over is quite an important element.

MR. MCILHENNY—I stated in the paper that the secretary had charge of the clerks and meter-takers, and all the details incidental to the collection of the bills; and that the money was to be paid to the treasurer, and that he was to deposit it and make a correct return of it to the company.

MR. HARBISON—I think there is one point in connection with Mr. McIlhenny's paper that the Association did not take in, and that is this: as he was reading his very interesting paper, and as the points were being brought out, it was very clear to me, as he looked around the room, that he must have had a very intimate acquaintance with the personal merits of the members of this Association. In defining the qualifications that are necessary for a first-class president, he had in view, I am sure, half a dozen gentlemen who are present; and when he was defining the duties and qualifications of a secretary, he also cast a meaning glance around the room. I want

to call attention to this point, because it shows that his acquaintance is not simply limited to gas making, but he is also well acquainted with the qualifications and the calibre of the members of this Association. [Laughter.]

DR. SLOANE then read a paper as follows:

RELATION OF THEORY TO PRACTICE IN THE GAS FLAME.

It is well known to us all that heat, in its industrial applications, is wasted to a great extent. The old problem of the conversion of heat of low into corresponding heat of high temperature, has to be solved, and to its non-solution the waste in most cases is due.

Theoretically, one pound of coal should melt forty pounds of iron, yet this result is never even approached in metallurgical practice.

I wish to examine very cursorily the loss of heat in a gas flame. Light is here produced by intense heat; the combustible gases are peculiarly fitted to produce such heat, because, as they are already in the gaseous state, they do not in their combustion have to make the step from solid to gaseous, as solid combustibles do.

The light given by the flame is due to the ignition of particles of solid matter. Carbon is present in the unignited gas in combination with hydrogen, as constituent atoms of gaseous hydrocarbon. When the gas burns, the heat of the flame decomposes these compounds; solid carbon, in a state of almost molecular division, is liberated; and becoming white hot or incandescent, emits light. It travels upward through the flame, until, reaching the top and outer zones, it is burnt into carbon dioxide, commonly called carbonic acid gas.

All the light of gas is due to the ignition of this carbon. The proof of this fact is this: while gases and liquids ignited may give light, it can always be determined by spectroscopic analysis whether light is due to an ignited gas or not. Theoretically and in fact, the spectrum of light derived from the ignition of a gas is discontinuous, while liquids and solids ignited give a continuous one. On subjecting the light of illuminating gas to this examination, it is found that it is due to the ig-

nition of solid or liquid matter, because its spectrum is continuous. As there is no reason for the belief or probability that there is a liquid there present, we find that its light is derived from an ignited solid; and by analysis we find that carbon is the only substance present that remains in the solid state at elevated, or even ordinary temperatures.

This proves the fact. A *quasi* proof is found in the deposition of carbon, in the form of lampblack, upon a cold body immersed in the flame. Therefore, as a light producer, all the work of a flame is the heating of carbon to a white heat.

I shall now proceed to consider the arithmetic of the process, to show what waste of heat takes place, and what a sacrifice of economy to convenience the whole operation is.

I will start with a gas composed of the following principal constituents:

	By Weight.	By Volume.
Hydrogen (H)	5·00	50·00
Marsh Gas (CH_4)	63·00	39·40
Carbon monoxide (CO) . .	19·00	6·70
Olefiant gas (C_2H_4)	11·00	3.93
Water (H_2O)	2·00	1·11

This represents about such a gas as is now delivered in New York. For ease of calculation, I will use the analysis by weight, and refer everything to 100 parts of the gas.

The olefiant and marsh gases supply the flame with its solid carbon; and, to make every allowance, we will assume that all the carbon contained in them is dissociated, and plays its part in producing the light of the flame. They contain 56.67 parts of this carbon. The heat developed by burning each of the combustible gases, has been determined by physicists. If we multiply the amount of hydrogen and other combustible gases, each by its own heating power, we shall have the total heating power of the flame. Thus, one part (by weight) of hydrogen will raise 34,462 parts of the water one degree centigrade; therefore, $34{,}462 \times 5 = 172{,}310$ is the number of parts of water which the five parts of hydrogen in the gas under consideration will raise one degree centigrade in temperature.

Performing a parallel computation for all the constituents

that will burn, we find that 100 parts of the gas will raise 1,169,-317 parts of water one degree centigrade. 1500° Centigrade is not far from the temperature of the incandescent carbon. We will assume that this number of degrees of heat has to be imparted to the carbon, by the flame. Dividing 1,169,317 by 1,500, we have 779.5, the number of parts of water which one hundred parts of gas will raise 1,500° centigrade. But 100 parts of this gas, in their combustion in air, will have to heat 815 parts of nitrogen, derived from the atmosphere. Multiplying this number by .2438, the specific heat of nitrogen compared to water, we obtain 198.69, the corresponding weight of water. This, plus the water in the gas, must be subtracted from the total work. Doing this, it gives as a result, that one hundred parts of our gas should be able to raise 578.8 parts of water 1,500° C. If we divide this number by .2411, the specific heat of carbon, we shall have the corresponding weight of carbon, or 2,400. Dividing this (the theoretical) by 56.67 (the actual) efficiency of gas, we obtain 42.4 as the figure expressing the relation of theory to practice; in other words, the gas in its combustion generates enough heat to produce 42.4 times the light it does.

The efficiency of gas, I have determined on the supposition, that all the carbon in the marsh gas plays its full part in the illumination. But this is not true; the light is due almost entirely to the olefiant gas. The supposition that it is the carbon of this constituent, mainly, that is dissociated and made incandescent, is more than probable.

This carbon in the gas under consideration, amounts to 9.43 parts. Substituting this figure for 56.67, in the former calculation, our ratio of practice and theory is expressed by 254.50; or, the gas generates enough heat to produce 250 times the light it actually does. This figure seems, and I am not at all ready to say it is not extravagant; but even if it is so, the other one, the first deduced, is too small. The truth lies somewhere between the two, and indicates at least, a field for experiment.

On motion, a vote of thanks was tendered to Dr. Sloane.

MR. LITTLEHALES—I would like to inquire what is the best

means of ascertaining the temperature of a gas flame? Perhaps some members may know some ready method of doing so.

DR. SLOANE—I will refer that matter to Captain Dresser, who, I believe, has made some experiments in regard to the heat of retorts, and I suppose he will be able to give you information upon that subject.

CAPTAIN DRESSER—The experiments I made were not to determine the flame temperature of the gas burned, but they were a series of experiments, in rather a primitive way, for the purpose of determining the heat that was generated inside of the retorts. The method we used was as follows:

We had first six cast iron bars, of equal weight; then we had a little iron bridge or groove, with a stand on one end of it (the outer end), and that groove was laid on the charge, and reached about half way into the retort. Then these iron bars had let into them a piece of soft iron, shaped so that we could take hold of it with a small pair of tongs. We used the tongs for the purpose of catching hold of the bar and sliding it down this little incline into the middle of the retort. The self-sealing lid of the retort was then shut, and the bars were left there for different lengths of time. Then the bars were taken out at different periods, say half an hour, an hour, an hour and a half, and so on. As the bars were taken out they were thrust into water, the weight and temperature of which were known; then, by noting the rise in the temperature of the water that took place from the heat that was thrown out by the iron, a calculation was made, by an ordinary formula, given in the *Journal*, of November 16, 1877, for determining the heat of the iron. In these experiments we took the specific heat of the iron at .126. The same experiments have been tried by Mr. Greenough, in Boston, and elsewhere, I believe, and the results, in most of these cases, corresponded very nearly. Of course the method is not an absolutely accurate one, but, at the same time, if a series of experiments are conducted under the same conditions, they will give the same relatively correct results. The vessel into which we thrust the bars was made of galvanized iron, about two feet long and perhaps one foot deep. This was weighed each time. We used the same weight of water, for

facilitating the calculation. In each case the temperature of the water was taken before and after the immersion of the bar.

We had, as I say, six of these bars of iron, and when we pulled out one from the retort we put in another.

The putting in of this little bridge or groove, and sliding these pieces of iron into the retort, was found necessary, because it was difficult to see where the iron went when it was put into the retort. We found that sometimes it would slide down under the coal, and sometimes it would just touch the top of the charge; and in order to make the results reliable, we found it was necessary to place the bars in the same relative position in each experiment. We found that in order to make a fair average it was better to put the bars in the middle of the retort, on top of the coal; and, as we could not see where the bars went every time they were inserted in the retort, this bridge or groove was used for the purpose of a guide, to enable us to put the bars into the same place.

Mr. Littlehales—I am very desirous of finding out whether there is any practical method for ascertaining the temperature of the retorts. We often hear gentlemen speak of their retorts being at such and such a temperature; and I would like to know if there was any method known by which we can test what the temperature of the retorts may be, and be sure that we are right.

Capt. Dresser—You can get at the temperature by this means. There is a certain formula which I do not carry in my mind, but which I can get very easily and give you at some future time, containing certain unknown quantities, and these unknown quantities are supplied by the temperature of the water before and after the immersion of the bars. Then, by working out the equation, it gives the temperature of the iron. I can give you the equation, and explain the matter to you, at any time.

Dr. Sloane—What is the weight of these bars of iron, or the general size of them?

Capt. Dresser—The pieces of iron that we used were, perhaps, an inch and a half or two inches in diameter, and about one foot long.

Dr. Sloane—You immersed them in a tank constructed of galvanized iron ?

Capt. Dresser—Yes, sir.

Dr. Sloane—Was there a strong evulsion of steam ?

Capt. Dresser—No ; there was not.

Dr. Sloane—That was done away with entirely ?

Capt. Dresser—Yes, sir. Of course the bars had to be handled very quickly and very skillfully. In performing this experiment you need the services of a handy man to do some of the work, and then you can stand around and make the figures. (Laughter) You want a man who has got some intelligence and dexterity to handle the tongs, and not allow these pieces of iron to fall on the floor.

The Jablochkoff Candle.

I wish to say that, through the kindness of Mr. Rowland, I have here a Jablochkoff candle, which came from the laboratory of Mr. Jablochkoff. He kindly gave me one for the benefit of this Association, but I have given it to Prof. Morton, and Mr. Rowland has let me have this one that he obtained in Paris. Mr. Jablochkoff told me that they could not be bought—that they were not for sale—and that he had no right to give them away. He said he would give me one with a great deal of pleasure; but that it was only in case they were for the use of scientific societies that they were presented. I immediately presented a card upon which I had printed quite a list of places that I frequent. One of the announcements on the cards was that I was an honorary member of the American Gas-Light Association, and another was that I was the secretary of the Society of Gas-Lighting, and one or two other things. Immediately, upon handing him this card, showing that I belonged to so many scientific bodies, he presented me with a candle which you will see to-night. Mr. Rowland, I presume, obtained one in a similar way. (Laughter and applause.)

These two little black streaks are the carbon, and the white streak is the kaolin, or plaster of Paris, that separates it. They put four of these on a stand and lead wires up to them. The current used by Mr. Jablochkoff is an alternate one. He has

two machines—a large one and a small one; and by that means one of these carbons would be positive at one time, and the negative at another. So that the current goes from one to the other alternately, and in that way he secures an even burning of the two carbons. They burn down nearly the whole distance, and burn down quite evenly. When one of them is nearly burned out a man has to go to the lamp-post where they are, and, by a switch, he switches the current from the one that is burned to the next one, and so on. One of these candles will burn from an hour to an hour and a quarter, and as there are four to a lamp they will burn about five or six hours, and then they have to be replaced by others. You observe, therefore, that that costs something, in the way of expense for attendance. The light furnished by these candles is quite a steady light for an electric light.

They are burned inside of a large oval globe, about twenty inches in diameter. Of course there is a certain loss of light from the use of these translucent globes, but the object in using them, as explained to me by Mr. Jablochkoff himself, was to present a larger surface, so that he could get more diffusive power, showing that even in Russia they have the true idea of light—namely, that its diffusive power depends upon the surface of the flame, and that a large burner gives more light in proportion than a small one. I do not think that Prof. Morton will be able to show this candle very well to-night, because I do not think that he has one of these alternate current machines. He might light it, just to show what the light was, but he could not display it properly without the proper machine.

The moment these carbons get separated a certain distance the voltaic arc would cease to pass. He takes the current around to four of these lamp-posts at once, and if any one of them goes out the others must go out. In the Orangerie, in the Garden of the Tuilleries, they have forty-eight of these lights burning. These are run by two 35-horse power engines, which are worked to their full capacity, and three large electric machines and three small ones, for reversing the currents. That was the apparatus that was necessary for running the forty-eight lights.

Mr. Harbison—How long does it take a man to make a change from one candle to another on the lamp-post?

Capt. Dresser—The change from one to the other is made by the mere turning of a switch. Each one of these candles, as Mr. Jablochkoff told me, cost about 65 centimes, which is about 13 cents. I see, in a proposition that he made to illuminate certain buildings, he estimates the cost of these candles at 55 centimes, which would be about 11 cents. In the report which was published in the last number of the *Gas-Light Journal*, upon this matter, I averaged the cost at 12 cents.

Mr. Cartwright—How do they arrange the controlling power in lighting a long street, or a long row of lamps?

Capt. Dresser—They put the steam engines in the cellars of buildings, and their other machines in the same place. Wires are run from the machines to the lamps.

Mr. Littlehales—What is the greatest distance that the candles may be placed from the power?

Capt. Dresser—They claim that they can carry it about five or six hundred yards. You will find, however, that when they are making experiments in their laboratories, and even at the Exposition, that they prefer to use about two hundred feet of wire—that is, from their machines to their lamps—because it takes a smaller wire, and is more easily handled.

Mr. Cartwright—Do they have a return wire?

Capt. Dresser—Yes; they have a double wire.

Mr. Cartwright—Do they have the wires covered?

Capt. Dresser—They were all, apparently, covered wires.

Mr. Cartwright—How far apart are these candles lighted, generally speaking?

Capt. Dresser—On an average, one of these electric candles replaces about ten gas burners. I have just received, since this Association has been in session, a report made by Mr. Hunt, who is the engineer of the Birmingham Corporation Gas Works, and who was in Paris at the same time I was. He has kindly forwarded me a copy of his report, and, if you would like to hear what it is, I will read it.

Mr. Harbison—I move that it be printed as a part the of proceedings. Carried.

Capt. Dresser—Mr. Hunt is a man of a great deal of intelligence. He is a thorough gas maker; he is, at the same time, I believe, a perfectly fair-minded man, and is willing to find out everything he can in favor of the electric light.

Mr. Harbison—The reason I suggested that the report be printed with our proceedings is, that it is very possible that there may be those who, after hearing this interesting report read, will want to subscribe to the *Journal*, in order to get the report.

Capt. Dresser—I think, after hearing this report, if a man is mean enough not to subscribe to the *Journal*, we had better let him go. [Laughter.]

Capt. Dresser then read the report of Mr. Hunt, as follows:

CORPORATION OF BIRMINGHAM—GAS DEPARTMENT.

Report of Mr. Hunt on Electric Light.

I have to report that, agreeably with instructions received through the Secretary, I endeavored, while in Paris, (on the occasion of the visit of the British Association of Gas Managers) to procure such information as was obtainable on the subject of lighting by electricity, as partially adopted in that city—its cost, practicability and effect, for the purpose of ordinary illumination. I was further requested to prolong my stay, in order to witness the effect of the extensive preparations then in progress for a general illumination, by means both of gas and electricity, on the 30th of June, the day appointed to be observed as a National Fete.

By the courtesy of M. Denayrouse, the Managing Director of the Electric Light Company, the members of the Association were permitted to visit the works of the company in the Avenue de Villas, and there inspect the apparatus in preparation for producing the electric light; and afterwards, on the same evening, were admitted to the Concert at the Orangerie, at which place 52 electric candles are in use, and where the engines and machines were open to the inspection of the members.

Subsequent interviews were arranged between M. Jablochkoff (the inventor of the electric candle) and five of our number, including the President of the Association and two American engineers, one being the Editor of the *American Gas Light Journal.* At each of these interviews I was present, and am pleased to testify to the patience and attention with which our inquiries were met.

The system adopted by the company, and to which my attention was mainly directed, as being the one almost exclusively employed in Paris, is that devised by M. Jablochkoff, the distinctive features of which are, as is well known, the production from the same source of more than one light, and the employment of what is termed the "candle." This latter is an ingenious substitute for the lamp and regulator, with their attendant conveniences, and consists of two carbon rods, placed vertically side by side, and having between them throughout their entire length, and isolating substance called kaolin. The intervening space between the rods being just sufficient to admit of the formation of the voltaic arc, is temporarily bridged over at the tip, which latter is ignited by the electric current, and the candle burns slowly down, the kaolin being consumed at the same rate as the carbon. I am able to produce one of these candles for the inspection of the committee. They were stated to cost 75 centimes each. Each lantern is provided with four, and sometimes five candles, placed in sockets upon a brass table; and the electric current is communicated to one or other of them, as may be desired by means of a commutator, worked with a switch arrangement, attached to every lantern. As each candle lasts, while burning, only from one and one-quarter to one and one-half hours, constant attendance is necessary for the purpose of changing them—a difficulty, which it seems possible might be overcome by means of some automatic arrangement.

The candles are enclosed in thick opal globes, 50 centimetres in diameter, equal to 19.68 inches, English measure, which, while they diffuse and soften the light, effectually subduing its piercing brilliancy, very considerably diminish its intensity. It is admitted that the loss in this way amounts to 30 per cent. of

the light generated; and, judging from the effect of similar globes upon gas-light, I believe it to be very much more. Each candle is estimated by the inventor to give the light of 110 carcel lamps, which, at 9.6 candles per lamp, equals 1,056 sperm candles; from this has to be deducted the 30 per cent. absorbed by the globe, leaving 739.2 sperm candles, as the available light given by each electric candle. This, however, is an evident exaggeration. I estimated the light at about 200 candles, and others with whom I conversed considered it comparable with about 15 ordinary gas burners—a value pretty much the same as my own.

The machine employed for producing the electricity is the magento-electric machine of M. Gramme—a compact and powerful apparatus, to which, I believe, I am correct in attributing any practical success which has yet been achieved in the direction of distributing the light from more than one focus. As full descriptions of this machine have appeared in several scientific periodicals* in this country, it is probably unnecessary that I should refer to it in detail. Two sizes are now made—one capable of sustaining four lights placed upon one circuit, and a larger one for sixteen lights upon four circuits. The cost of the smallest is 3,000 francs, or £120 each, exclusive of a four-horse engine and boiler, the power required to drive them being about one-horse power per candle.† The maximum distance from the machine at which the current can be advantageously transmitted is 800 yards; and it also transpired that all the candles upon the same circuit or machine are of uniform intensity, it having been found extremely difficult, if not impossible, to produce them of varying intensity from the same source.

Amongst others, the following places are lighted by the method above described:—

Place de l'Opera.
Avenue de l'Opera.
Place du Théatre Francais.
Front of the Corps Législatif.

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* See "Engineer," Dec. 21st, 1877. See "Engineering," July 26th, 1878.

† This is an under-estimate; for in every case, so far as we had opportunities for observing, a much greater power was employed. It would be safer to take it at two h. p. per candle.

Place du l'Etoile.

Hotel du Louvre (Courtyard).

Magazin du Louvre (Interior).

" " (Front).

Orangerie (at corner of the Gardens of the Tuileries).

Hippodrome, and the.

Workshops of the Electric Light Company.

Its effectiveness, as thus displayed in some of the most frequented parts of the city, with the brilliant appearance of which it is impossible not to be impressed, is beyond question; and goes far to prove its general adaptability for open air illumination, and for the lighting of large public buildings or workshops. The eye does not appear to experience any but the slightest sense of fatigue, the otherwise intolerable intensity of the light being almost entirely subdued, but there still remains an objection, which it is thought, by some, to have considerable force, namely, that it imparts to the countenance a somewhat unnatural hue. Its employment, however, at such places as the Magazin du Louvre, the Orangerie and the Hippodrome, seems to show that whatever importance may attach to this objection, is outweighed by other considerations. At the Hippodrome, an immense oval building, 341 ft. long, by 223 ft. wide, which is crowded nightly, an excellent effect is produced by 14 reflected electric lights, and 20 suspended "candles," the balconies and orchestra being in addition, lighted with gas. When, during one portion of the performance, it was desired to darken the arena, this was readily effected by withdrawing the 14 reflected lights; and these, after a short interval, were again put forward without any apparent difficulty. At the nightly concerts at the Orangerie, the orchestra and stage are lighted entirely by electricity, as are, also, the long promenade and hall. The promenade is about 32 yards wide, and the candles are placed about 26 yards apart, so as to form one row down the centre. I was able to read a newspaper without the slightest difficulty, at the furthest distance from any of the candles. It was here, however, that in the course of the evening I observed a considerable unsteadiness in the light, as though the engine power was not being properly maintained; and a disagreeable pink light

was the result, when, as happened several times, the candles were allowed to burn a little too long.

On the evening of the fete day, a very pleasing effect was produced by the simultaneous lighting of two long rows of candles, extending through the trees along the entire length of the Gardens of the Tuileries, suggesting a wish for the better success of the endeavors that have lately been made to light and extinguish our own gas lamps, by the same agency. Except, however, for special objects, such as the illumination of fountains and cascades, gas is much to be preferred for the purposes of a general illumination, its superior divisibility rendering it peculiarly adapted for the production of artistic effect.

The prominent characteristic of the electric light is, of course, its concentration, but this, which probably constitutes its chief value as an out-door illuminant, is a fatal obstacle in the way of its general adoption; and hence, it is only natural that its advocates should endeavor to overcome this by attempting a more minute subdivision of the electric current than has yet been acheived. We were shown, by M. Jablochkoff, at the Pavilion of the Electric Light Company, in the Exhibition, an arrangement by which, he has succeeded in producing, at will, two ordinary or four smaller candles from the same source; but the cumbrous nature of the apparatus employed, precludes the possibility of its possessing any immediate practical value.

With regard to the question of comparative cost, it is clearly not necessary to invest the fact of the employment of the electric light in Paris during this exhibition period, with any special significance, since it may be fairly assumed that, under the circumstances, other considerations would be allowed to have at least equal weight; and the fact that, in the principal thoroughfares lighted by this method, "Coal gas resumes its sway," as a recent writer to the *Times* expressed it, shortly after midnight, shows pretty clearly that the Municipality have not yet made up their minds to abandon its use. In the Avenue de l'Opera, and Place of that name, to which this observation more particularly applies, 180 ordinary gas lamps are every evening temporarily displaced by 30 electric candles, being in the proportion of one to six; and as the Municipality

pay for the candles at the rate of 1 franc 25 centimes, or about 1s. per hour, each, while gas for six burners would cost for the same period, at 7s. per 1,000 cubic feet, which is about the price of gas in Paris, a little less than 3d., it is apparent that the candles are a luxury in which it is quite possible too freely to indulge. It is, however, only right to state that the light given by them is much superior to that afforded by the gas lamps, used in the above proportion; but if the comparison be made upon equal terms, it will still be found to be very much in favor of gas. For instance, if we assume that the light given by one electric candle be twice as much as what I conceive to be a fair estimate, viz., 200 candles, then the comparison will be between the light of 400 candles distributed from one focus, and costing 1s. per hour, including attendance, wear and tear, and, it is to be presumed, promoter's profit—and 30 gas lamps distributing their light, as a matter of course, over a far greater area. The latter would cost—

For gas, at 3s., 150 cu. ft. per hour . . .	5.4d
To which add, for lighting, cleaning and extinguishing, say 20 per cent. or . . .	1.08
Total	6.48

Or, say 6½d., which, deducted from the 1s., as above, leaves a balance of 5½d. in favor of the gas, in addition to which there has to be taken into account the undoubted economy resulting from the far greater area which would be illuminated by the latter.

It will be apparent from the foregoing that, while the electric light possesses certain advantages which may procure for it a limited amount of favor for special purposes, these advantages are accompanied by such serious drawbacks as to render it unsuitable for general employment; so that although in some particulars, as in the cost of the "candle" proper, it would seem to be a matter of no great difficulty to effect improvements, suggesting the desirability of watchfulness over any progress that may be reported, there appear at present to be no grounds for believing that coal gas is likely to any extent to suffer from the rivalry with which it has for some time past been threatened.

CHARLES HUNT, *Engineer*.

WINDSOR STREET, *August 5th*, 1878.

Since the above was written I have been favored with a sight of a copy of an estimate, given by M. Jablochkoff to the managers of a club house in Paris, for the supply of apparatus complete, including magneto-electric machine, five or six horse-power engine and boiler, lanterns, wires, and every other requisite, fixed ready for use, the cost for four candles being 11,623 frs. 50 c., or nearly £465.

He further estimates the cost of maintaining the four lights, including the candles, attendance and fuel for engine, at 3 frs. 54 c. per hour, or 2s. 10½d. English.

MR. HARBISON—While upon the subject of electric light I will state that some of the members understood Mr. Nettleton to say that the light, as used by Mr. Wallace, was without a return wire. If he is here I would be glad if he would be kind enough to repeat his statement in that respect.

MR. C. H. NETTLETON—As I understand him, and I think I am correct, the wire is run from the machine around the shop, and back to the machine again. In that sense it is a return wire. But whenever he wishes to put in a lignt, or a candle, he cuts the wire and inserts the candle.

His machines are of different sizes. He has them from two lights each, up to eight lights, and, I think, twelve lights. But those candles are all on one wire; and, furthermore, he has it so arranged that he can put out one candle, and all the rest will remain just as well as if all were burning.

MR. HARBISON—In regard to the subject of testing the temperature of retorts; in addition to what Captain Dresser said, allusion was made to the fact that some experiments had been made by Mr. Greenough, of Boston. Mr. Greenough gave us, at the New England meeting, a very interesting report of some experiments that he had made; and I think it will be of great interest to those gentlemen who were not in Boston if he will repeat that statement here, and give us the results of the experiments that he made in regard to the temperature of the retorts during the burning out of the charge.

MR. WOOD—Before we come to that I would like to inquire of Captain Dresser one thing. If I understand him, he says

that there are four or five candles placed in one lamp, and that these burn for five or six hours.

CAPTAIN DRESSER—Yes; burning one at a time. They burn one and then light another. They are not all lighted at once. Each one of these burns about an hour or an hour and a quarter; and, as there are four of them, each lamp will last about five hours.

A MEMBER—Did you test the heat of the electric light?

CAPTAIN DRESSER—I will state that, so far as the lights in the Exposition were concerned, they were in such a shape that we could not get at that. But the Chartered Company, of London, have bought an electric machine, and a series of experiments are being made, by Mr. Sugg and Mr. Evans, to determine all these points. I was present with Mr. Sugg several times when experiments were being made, and we found that there was a great deal of heat in these lights. There must, of necessity, be a great deal of heat because it is this intensely heated carbon point that gives the light.

THE PRESIDENT—Will Mr. M. S. Greenough explain his experiments in accordance with Mr. Harbison's request?

MR. GREENOUGH—I do not think there is the least difficulty in obtaining a tolerably accurate estimate of the heat of your retort. The method which we adopted in the experiments made in our works is the one that has been in use for many years in France, and, not only in France, but in various parts of the Continent, though not, I think, in England. It is simply an application of the principle of specific heat. It is, of course, known to every gentleman here that a given weight of one material will be more affected by a certain quantity of heat than an equal weight of another material. In the case before us, for example, if you take a certain weight of iron, say, five lbs, and leave it in the retort until it has been thoroughly heated, and then immerse that iron in a given weight of water, say, 40 lbs., the temperature of which has been previously taken, it is very easy to calculate what the temperature of the iron must have been when it was immersed, by noting the increased temperature of the water afterwards. You may not get, perhaps, within 50° of the temperature; but I have no

hesitation in affirming my belief that, in the retorts I have experimented with, we have came as near as that. It is part of the ordinary operation of all our works, to thus test the temperature of any retort of the heat of which there is any question. I think gentlemen who have not made the experiment, and who are running charges, as they do in some works, of five or six hours duration, would be very much astonished to find how great is the reduction of temperature in the retort that actually takes place after the charge has been put in. It is very large, even for comparatively light four-hour charges. Take, for instance, an ordinary sized retort, and put into it a charge of 225 pounds of coal. The temperature of the retort before it was put in would be probably about 2300°; after the coal has been put in it will be some time before it is heated to a thousand degrees. At the end of an hour it will hardly get over 1400°. The heavier the charge put in, of course, the more the temperature will fall in the retort. If some ingenious plan could be devised similar in principle to Clegg's revolving web retort, by which only a small amount, say, 50 lbs. of coal, should be exposed to the action of the retort, at one time, we should all be surprised, I think, at the results obtained.

On motion, adjourned until ten o'clock to-morrow.

THIRD DAY.

The Association met at 10 A. M., pursuant to adjournment, and was called to order by the President.

On motion, the reading of the minutes of the proceedings of yesterday's meeting was dispensed with.

MR. NEAL—I move that the thanks of the Association be tendered to Prof. Morton for the instructive and interesting lecture delivered by him in the presence of this Association, and others, last evening, at the Stevens Institute. Carried.

The Executive Committee then made the following report:

The Executive Committee offer the following recommendations—

On Motion, It was resolved to recommend that hereafter the fiscal year shall be considered closed on September 30th of each year.

On Motion, Further recommended to amend Art. I. of the Constitution, by striking out the last clause.

On Motion, Also, that Sec. XVII. be amended, by striking out "In the City of New York," etc., leaving it as follows: "The Annual Meeting of the Association shall be held on the 3d Wednesday of October, of each year, at 10 o'clock, A. M., at such place as shall be designated by the Association at the previous annual meeting."

Also, Amend Art. XXVIII., so as to read: "No member who shall be two years in arrears shall be entitled to vote, or to participate in the deliberations of the Association."

Also, It was recommended that the next annual meeting of the Association be held in the city of Philadelphia.

Also, That the vote upon the recommendation relative to printing be reconsidered, and that the proceedings be printed in a volume similar to the last preceding volume.

Also, That the same committee be appointed to have the printing done.

Also, Recommended that Prof. Henry Morton be elected an honorary member of this Association.

Also, That the Secretary be and he is hereby directed not to furnish copies gratuitously to any member who is in arrears for annual dues.

The Committee ask the approval of this report.

W. H. DENNISTON,
Chairman.

On motion, the report was received.

THE PRESIDENT—So far as the recommendation of the committee is concerned, in relation to alterations in the constitution, that is a matter that must lie over until the next Annual Meeting. The first recommendation of the committee that requires the present action of the Association is, "that hereafter the fiscal year shall be considered closed on the 30th of September of each year.

MR. DENNISTON—The secretary and the finance committee have had some difficulty in fixing the time at which they can close the treasurer's account, and ascertain the amount of of money in his hands. Heretofore there has been a lap between the years, and the purpose of this recommendation is to fix a time to which the treasurer for the current year will report, and hand over the money in his hands to the treasurer for the following year. The recommendation was then adopted.

On motion, the recommendation of the committee fixing the place for the next annual meeting at Philadelphia, was adopted. The recommendation of the committee, that the action of the Association yesterday, in regard to printing the proceedings, be reconsidered, was, on motion, adopted.

MR. DENNISTON—The committee propose that, instead of the resolution adopted yesterday, it shall read as follows:

Resolved, "That the proceedings of the last meeting, and of the present meeting, be printed in a book similar to the last volume, and that the same committee have the printing done."

The resolution was adopted.

On motion, the recommendation of the committee, that Prof. Henry Morton be elected an honorary member of the Association, was adopted.

THE SECRETARY, *pro. tem.*, Capt. Dresser, was authorized to cast a ballot for the Association.

THE PRESIDENT appointed Mr. Neal as teller.

CAPT. DRESSER then proceeded to cast the ballot of the Association, and the teller reported that Prof. Henry Morton, Ph. D., was unanimously elected.

THE PRESIDENT—I am happy to announce that Prof. Henry Morton has been unanimously elected an honorary member of this Association. [Applause.] As an additional inducement to members to pay up their annual dues, the committee recommend that the secretary be directed not to furnish copies gratuitously to any member who is in arrears for annual dues.

On motion, the recommendation was adopted.

On motion of Mr. Harbison, the roll of the Association was then called, and the following members were found to be present:

HONORARY MEMBERS.

Capt. G. Warren Dresser,
W. W. Greenough.

ACTIVE MEMBERS.

Chas. S. Allmand, Norfolk, Va.
Jno. Andrews, Chelsea, Mass.
H. A. Allyn, Cambridge, Mass.
Jno. Balmore, N. Y. City.
Isaac Battin, Albany, N. Y.
Wm. H. Bradley, Brooklyn, N. Y.
Geo. Buist, Halifax, N. S.
Wm. R. Beal, N. Y. City.
Jno. W. Bates, Hoboken, N. J.
T. A. Bates, Evansville, Ind.
E. Breese, Detroit, Mich.
Geo. D. Bill, Malden, Mass.
A. H. Barrett, Louisville, Ky.
Geo. D. Cabot, Lawrence, Mass.
Matt Cartwright, Buffalo, N. Y.
O. E. Cushing, Lowell, Mass.
H. F. Coggshall, Fitchburg, Mass.
N. B. Crenshaw, Philadelphia, Pa.
Henry Cartwright, Philadelphia, Pa.
John Cartwright, Poughkeepsie, N. Y.
Jno. S. Chambers, Trenton, N. J.
Thos. C. Cornell, Yonkers, N. Y.
Wm. Cartwright, Oswego, N. Y.
W. H. Denniston, Pittsburgh, Pa.
Dorchester Gas Light Co., Dorchester, Mass.
Geo. Dwight, Springfield, Mass.
F. J. Davis, Waltham, Mass.
M. N. Dial, Terre Haute, Ind.
H. H. Edgerton, Fort Wayne, Ind.
H. H. Fish, Utica, N. Y.

Wm. Farmer, N. Y. City.
F. W. Gates, Hamilton, Canada.
M. S. Greenough, Boston, Mass.
L. P. Gerould, Newton, Mass.
Wm. G. Gardner, Pittsburgh, Pa.
Chas. A. Gerdenier, Bridgeport, Conn.
J. Pearson Gill, N. Y. city.
W. W. Goodwin, Phila., Pa,
H. F. Gerould, Cairo, Ill.
Jno. P. Harbison, Hartford, Conn.
L. C. Hanford. Norwalk, Conn.
A. Hickenlooper, Cincinnati, Ohio.
George S. Hookey, Augusta, Ga.
Jas. How, Brooklyn, N. Y.
Alex. C. Humphreys, Bergen Point, N. J.
Wm. Helme, Atlanta, Ga.
Jos. Hendly, Beloit, Wis.
I. Herzog, N. Y. city.
Thos. C. Hopper, Clarksville, Tenn.
M. Harrington, Niagara Falls, N. Y.
Edward Jones, South Boston, Mass.
T. Littlehales, Hamilton, Canada.
Edwin Ludlam, Brooklyn, N. Y.
P. Munzinger. Doylestown, Pa.
L. G. McCauley, West Chester, Pa.
Jno. McIlhenny, Phila, Pa.
Richard J. Monks, Boston, Mass.
C. F. Maurice, Sing Sing, N. Y.
Lewis Moss, Sandusky, Ohio.
W. H. Miller, Columbus, Ohio.
Geo. A. McIlhenny, Washington, D. C.
Hugh Murphy, Sing Sing, N. Y.
Jno. H. McElroy, Pittsburg, Pa.
Geo. B. Neal, Charlestown, Mass.
Jno. W. Newell, New Brunswick, N. J.
Chas. H. Nettleton, Derby, Conn.
Chas. Nettleton, N. Y. city.
F. H. Odiorne, Boston, Mass.
T. J. Pishon, Roxbury, Mass.

Saml. Prichitt, Nashville Tenn.
Albert D. Perry, Portsmouth, Va.
W. H. Pearson, Toronto, Canada.
W. H. Price, Cleveland, O.
Thos. F. Rowland, Brooklyn, N. Y.
Geo. K. Reed, Lancaster, Pa.
J. H. Rollins, Worcester, Mass.
Gen. Chas. Roome, N. Y. city.
Geo. Richardson, Wilmington, Del.
Jas. F. Rogers, Jamaica Plain, Mass.
A. B. Slater, Providence, R. I,
Marcus Smith, Wilkes Barre, Pa.
J. N. Stanley, Brooklyn, N. Y.
Jas. M. Starr, Richmond, Ind.
F. C. Sherman, New Haven, Conn.
Henry Stacey, Indianapolis, Ind.
O. G. Steele, Buffalo, N. Y.
Thos. B. Stephens, Tarrytown, N. Y.
Wm. A. Stedman, Newport, R. I.
C. F. Spaulding, Brookline, Mass.
F. A Stacey, Cincinnati, O.
Dr. T. O'Connor Sloane, Brooklyn, N. Y.
Thos. Turner, Charleston, S. C.
R. C. Terry, Phila., Pa.
Chas. C. Van Benschotin, New Rochelle, N. Y.
C. White, Rochester, N. Y.
W. Henry White, Brooklyn, N. Y.
Gideon Wood, New Bedford, Mass.
Austin C. Wood, Syracuse, N. Y.
T. F. White, Houston, Texas.
Robt. Young, Alleghany City, Pa.
Oscar Zollikoffer, N. Y. City.

MR. LITTLEHALES—There was a paper read before the last meeting of the Association, on the price of gas. It was left over, to be discussed and considered at this meeting. When it was read it was supposed by some that there was something in it that might be considered a little objectionable, and that paper has not been taken up yet, I believe. I move, therefore,

that it be entered upon the proceedings of the Association. I think it would be a great mistake to have the impression get abroad that any questions which are presented here, in the shape of papers, or otherwise, are not fully and fairly discussed, I have read the paper over very carefully, and I cannot perceive that there is a single sentence in it that is objectionable, in any sense, or that there is a single expression in it that cannot be endorsed by every gentleman present.

MR. PRICE—Every paper that is read must be entered on the minutes of the Association.

MR. LITTLEHALES—The paper was read; and a motion was made, and carried, that its consideration and discussion be deferred until the following meeting; and I, therefore, move a consideration of it now.

MR. HELME—It seems to me to be very late in the day to bring that paper up now. It is a very lengthy paper, and there are a great many points in it which many members of the Association do not concur in; and, I have no doubt, hours will be spent in discussing it. I, therefore, move that it go over until the next meeting.

MR. HARBISON—I think that is rather an unfair way of meeting the question. There are many gentlemen present who, perhaps, have not heard the paper read; and, as its consideration was deferred until this meeting, I think we ought, in fairness and justice to its author, take it up now. Besides, we have just decided to print the proceedings of the last two meetings, one at Cincinnati, and the other here, and if this paper is not now taken up, it will not appear in the published proceedings, and it cannot be printed and distributed before another year. Even if there is not time to discuss it, there is no reason why it should not be read and printed, as other papers are. It has been the custom of this Association, from its organization, to discuss fairly the papers that are presented before it; but this paper has not been discussed at all. I think Mr. Patton's views are entitled to proper consideration and respect, whatever they may be. I do not think we ought to defer the consideration of it until another meeting.

MR. HELME—I am under the impression that the paper was

sent by Mr. Patton, and that he was not present at the meeting when it was presented. In justice to Mr. Patton, I think, its discussion should be deferred until he is present, so that he may have an opportunity of sustaining his views by argument. He is not here to-day, and I do not think it would be just to him to take it up in his absence. There is in the paper a vast amount of matter which many of us would take exception to, or, at least, there are many of us who would disagree with some of the positions he has taken. It would necessarily give rise to a long discussion; and I think that courtesy and fairness to Mr. Patton require that he should be present when such discussion is had, in order that he may reply to the criticisms and objections that may be urged against his paper; and, for that reason, I do not think we should take it up now. Of course I quite agree with Mr. Littlehales and Mr. Harbison that all the papers which are presented before this Association should be fairly discussed, but not in the absence of their authors, especially if they are likely to give rise to a long debate and the expression of adverse criticism. That is my principal reason for objecting to the paper being brought up now. Besides that, we are to close our session at 12 o'clock to-day; and as there are matters yet to come before us, that require our attention, it would be impossible, even if the paper were brought up, to discuss it fully and satisfactorily.

Mr. Harbison—We are here for three days, and while I do not wish, as far as I am concerned, to prolong the session one hour more than is necessary, I do not know that there is any obligation resting upon us to adjourn at twelve o'clock to-day *sine die* by any means. Mr. Patton asserts his position in his paper, and gives his reasons for the opinions he expresses; and I think the paper ought to be received and printed. We do not express our assent to the views presented by any member of this Association, because the paper in which he expresses them is printed. We may not agree with a single proposition he advances; but that is not a reason why his views ought not to be properly treated. If he thought there were points in his paper which might be assailed, and deemed it necessary to defend his position, he might have been here to do so. But

the fact that he is not is no reason why his paper should not be treated in the same manner that other papers are treated, particularly as he has not requested that its discussion be deferred until he can be present. If he had thought that his presence was necessary, he would, in all probability, have sent a request that the consideration of it should be postponed until he was here in person.

A MEMBER—I think it would be very unfair to take up this gentleman's paper, and discuss it in his absence, I think it would receive a great deal more consideration, and be far more satisfactorily and fairly discussed, if he were present, and had an opportunity to reply to whatever might be said against it; hence, I think it only just and courteous to him, that the paper should lie, as it does now, on the president's table, until he is here to join in any debate that may be had upon its merits.

THE PRESIDENT—The motion before the Association is, that the discussion of this paper be postponed until the next annual meeting.

MR. C. WHITE—While I quite agree with Mr. Littlehales and Mr. Harbison, that this paper, like every other paper, should be properly and fairly treated by this Association, I think it is too late in the session to enter into the discussion of it now. Besides, I do not think it would be fair or just to Mr. Patton's views, to take up the paper in his absence. I, therefore, move as a substitute for the motion made by Mr. Helme, that the paper lie on the table until Mr. Patton is present.

MR. HELME—I accept that amendment. I will take the liberty of saying that, unless I am very much mistaken, there was a resolution passed yesterday, that we should adjourn *sine die*, at twelve o'clock.

MR. LITTLEHALES—If papers are to be treated in this way, and if they are not to be read or considered, except the writers are present, the result will be, that papers presented by gentlemen living at a distance, will simply be laid upon the table and ignored. I think there is some misapprehension about the contents of that paper. I have read it carefully, and I do not think there is a statement in it that any member of this Association can reasonably object to; and I cannot see why it should

be treated in the manner proposed. I sincerely hope that this Association, which has, heretofore, treated all papers presented to it in a fair and candid way, will not now, for the first time, make an exception to the rule it has heretofore uniformly adhered to. I greatly fear that such action will result eventually to our disadvantage, if not to our discredit.

THE PRESIDENT—Mr. Helme having accepted the amendment proposed by Mr. White, the question now before the Association is, shall the consideration of this paper be postponed until the author shall be present in person. Carried.

CAPT. DRESSER—I have received a letter which, with the permission of the Association, I shall read, inasmuch as it relates to the business of the meeting.

While in Paris, Mr. Forstall of New Orleans, promised to prepare a paper upon the Paris gas works, to be read at this meeting. He fully expected to do so when he left; but I received this letter from him a few days since. I read it in justice to Mr Forstall, to show why the paper was not presented. [The letter was read.]

MR. HARBISON—I move that the secretary be instructed to return Mr. Patton his paper with the action of the Association in regard to it. If he wishes to present the paper again to the Association, he can do so.

A MEMBER—The paper is laid upon the table; and that motion cannot now be made.

MR. HARBISON—I am not aware of any action of the Association by which the paper was laid upon the table.

THE PRESIDENT—The paper was not laid upon the table; but the discussion of it was postponed until Mr. Patton could be present. The paper cannot now be discussed; but the motion has been made that the paper be returned to the author, together with the action of the Association in regard to it.

A MEMBER—I move that the motion be laid on the table.

THE PRESIDENT—A motion has now been made to lay motion of Mr. Harbison upon the table. I presume the motion of Mr. Harbison is intended as a respectful act on the part of the Association toward Mr. Patton, that he may have an opportunity of reviewing his position, if he pleases.

The motion, to lay the motion of Mr. Harbison upon the table, was carried.

CAPT. DRESSER—On the subject of the next annual meeting, I would like to make a suggestion, and offer a resolution. It is usual, when the Association holds its meetings in New York, to appoint a committee to take the matter in charge, and make the necessary preparations for a hall, etc. Inasmuch as the Association has decided to hold the next annual meeting at Philadelphia, I move that Mr. Thos. R. Brown, engineer of the Philadelphia gas works, Mr. Henry Cartwright, Mr. Helme and Mr. W. W. Goodwin, who also, live in Philadelphia, be appoinf ted a committee to make the necessary preparations in Philadelphia for the meeting next year. Adopted.

MR. NEAL—We listened to a very interesting lecture upon the subject of " Electric Light" last evening, and there may be some members of the Association who desire to say something on the subject. It is a matter that is deeply interesting to us at this time, and I think we might spend a short time in discussing whatever may have been suggested by the lecture of Professor Morton. We might very profitably have a little interchange of opinion on the subject. The public are very deeply interested, and want to know all that can be learned about it. Every day the question is asked—"What do you think of it!" Personally, I reply, that I know very little about it; but I think that perhaps we might spend half an hour or so, very profitably, in talking over the matter.

THE PRESIDENT—We are ready to hear the expression of any views that may have presented themselves to the members of the Association, growing out of the lecture of Professor Morton.

MR. NEAL—I hope we shall hear the views of some of the members on the subject of electric light. It is a very grave subject, and one that perhaps some of us are afraid to handle. Still, there are some of the members who have had interviews with gentlemen who are connected with the manufacture of engines for producing the electric light, and they may be able to give us some information; and, while I am up, I will ask Mr. Helme, if a firm in Philadelphia has not tried electric light,

and made experiments with it in their workshops, and whether they have found it practicable?

Mr. Helme—I don't know that I can say much on the subject. We heard from Prof. Morton last night that the production of electric light was not a new thing, and it is known that it could be done twenty years ago, as he said; but, at that time, the cost of producing electricity precluded the possibility of its introduction as a means of illumination. Since then machines have been invented that produce electricity at a very much less cost; and the question now arises, can electric light be produced, by means of these machines, at such a cost, and be so diffused, that it will take the place of gas. For my own part, I have very little apprehension in regard to it, except in the way that Prof. Morton suggested last night, viz.: the illumination of public buildings and parks, and, perhaps, large hotels, Admitting that it does come into use that far, the question then arises—how much would the gas companies suffer from that. So far as my experience goes, I have made very little money from the lighting of streets or public parks, and I may say that I have made very little out of hotels, because hotels, being among our largest consumers, and because hardly able to afford gas, they always seek to get it at the lowest figure, and there is more or less difficulty in collecting the bills.

Now, there are several of these electric machines, as we all know. As the defects of one machine have been demonstrated by experiment, others have been invented, and are being invented. The attention of scientific men and inventors have been turned, within recent years, in this direction; and scientific attainment and mechanical ingenuity and skill are constantly at work, in this country and in Europe, in the attempt to solve the problems that are presented in the way of a perfect utilization of the electric light. The Franklin Institute, I believe, has bought a machine, and has appropriated $500 for experiments. The different makers were invited to send one of their machines for trial. These various machines were tried there, at the Institute, and experiments made with them. Finally, a Wallace machine was selected, and it did very well,

except that the ceiling was not high enough to get a proper elevation for the light. They lit several burners in the hall and in the library, and kept them for some weeks. There was no attempt at following it up, as Prof. Morton did. It was all right in many respects, and for certain purposes The first thing I knew, it came out that they were going to light the passenger sheds of the Pennsylvania Railroad Company, at West Philadelphia. Gen. Corliss, who happened to be the attorney of the inventor, said he would like to have me go over and look at it, and I said I would do so. I went over, and found that they had put four lights in the shed, two on each side. The engine was down about twenty feet below the shed, and about forty feet away from the edge of the shed. The engine was of ten horse power, and was worked up to its fullest capacity. They labored faithfully, but after running a little while with the four lights we could scarcely see across the shed. Then they shut them off for two hours, but they did not work at all satisfactorily, and they gave as a reason for it that the machine was too far away from the lights. I do not think the machine was over 60 or 70 feet from the lights. I would mention that in the Franklin Institute they had the machine in the cellar, and the nearest light was not, probably, over 20 feet from the machine, and the other one about 20 feet more, and therefore, I suppose, that was the reason why it worked so much better in the Institute than in the railroad shed. They went on, and tried, night after night, for about a week, to light the passenger shed of the Pennsylvania Railroad. Finally a notice appeared in the paper which read to this effect:—that a certain officer having charge of the depot had been authorized by the board to take charge of the whole matter, and nothing has been heard from it since.

For my own part, I do not feel any apprehensions that the light will interfere seriously with the consumption of gas. Even if the light can be diffused through the entire building, it becomes too strong to be pleasant. Now, in regard to putting in some of these lights in works at West Philadelphia, I would say that I called at the office of the works where they were introduced, and made inquiries there, but did not get much in-

formation one way or the other. Finally, I was informed by the person from whom I made the inquiry that they had had the light in there, but that it had not operated satisfactorily, and they had taken it out of all the rooms but one, and that was the folding room. I think we all know that that does not require a very brilliant light. They said they had tried it in their other rooms; but they had met with one difficulty, and that was that they could not get it high enough—that the ceilings were not high enough to admit of a proper elevation of the light. Another objection they had to it was this, that the shadow was so intense that operators frequently mistook the shadow for the thread; the consequence was they did not care to be bothered with it. A great deal has been said about putting it in other places, but I think that is about all that has been done, or is being done, in Philadelphia; but perhaps Mr. Cartwright knows more about it than I do.

Mr. Harbison—I would like to inquire of Mr. Helme why he does not wish to have street lamps as part of his consumption.

Mr. Helme—It is a little late in the session to give my reasons in full for the opinion I have expressed upon that point. I have had considerable experience in the matter of furnishing street lamps with gas, and the result of my experience has been that I have made very little money out of it. That remark was made quite incidentally, in speaking about electric light, and as that is the subject which we are now exclusively discussing, I do not propose to go into a discussion of the other question, or give my reasons in detail for the statement I have made.

Mr. Harbison—I would also like to inquire why Mr. Helme does not regard hotels as desirable consumers. I suppose he can have no objections to stating the reasons for the views he has expressed.

Mr. Helme—As I said before, it is too late in the session now to enter into a discussion of that question. That has been my experience, yet I do not mean to say, of course, that that is the experience of all gas makers. My experience has been that

you must furnish the gas at low figures, and wait a long time for your bills, and sometimes not get them at all.

MR. PRICE (in the Chair)—It is not intended that any subject but the electric light shall be discussed at present, I suppose, and therefore I think the members had better confine themselves to it. I do not suppose that the question of furnishing gas to hotels is a proper one for discussion at the present time.

MR. HARBISON—I think that my question is a proper one, in view of what Mr. Helme has said, and I hardly think he is justified in declining an answer. If there are any reasons known why the public lamps are not profitable consumers, I think the gas companies ought to know it. If there is any valid reason why hotel keepers are not profitable consumers, I think we ought to know that. Hotel proprietors are generally regarded as the largest and best paying consumers.

MR. HELME—I said, as a general thing, my experience was that I had made very little money from street lamps and hotel proprietors.

MR. PRICE—I do not think I can allow you to go on with the discussion of this question, as I think it is generally understood that the discussion is to be confined to the subject of electric light. However, unless there is a motion made to that effect, I do not know that I am authorized in making this ruling.

A MEMBER—I move that the discussion be limited exclusively to the subject of electric light. Carried.

MR. HELME—I find that there is a great difference of opinion among scientists in this matter. Prof. Morton sur-
ed me by some of the statements that he made in his lec-
t evening, because, in talking with a gentleman whose
n is the same as that of Prof. Morton, he stated that
l that all Mr. Edison had done, or that it was claim-
iends he had done, was possible. He is enthusiastic
ect. He is a firm believer in the future possibilities
ight. There is, as I said before, a great difference
ong scientific gentlemen of equal ability upon

this question, and where these learned savants disagree it is hardly to be expected that we should be able to arrive at the truth.

MR. CARTWRIGHT—As a gas stockholder I have been connected with gas companies for some years. I have watched the progress of electric light with an interest solely my own. Mr. Helme speaks of experiments made at the Franklin Institute in that direction, and of the results of experiments in the railway shed, at Philadelphia, and some other places; but he seems to forget that we have one other instance. I name the Exposition Building, which he probably has not visited since 1876. As the result of observations which I made, I would state that the building has been lighted two evenings a week, for some weeks, by six Brush machines, which supplied twenty-two burners situated in the central part of the main hall, which you probably all remember. They are driven from the main machine by a shaft. The operation is carried on by means of the engine provided for running the machinery of the Exposition, or, as it is now called, the Permanent Exhibition. They are run at a velocity of about 800 per minute, and when I saw them they appeared to be unsatisfactory in their results. They were heated a good deal; but the attendant told me they would get about so hot, and would not get any hotter. I suggested to him whether the effect upon the lights would not be more satisfactory if the velocity of the machine was increased. He said it certainly would; but that they were afraid to increase the speed because of the effect of the heat on the machines, and, therefore, they had to confine the velocity to about 800 per minute. The lights are scattered over what is termed the nave of the building, which is the portion at present appropriated for concerts and balls. I think on every Wednesday night they have a ball, and on every Saturday night they have a concert. The lights are scattered in both directions, and are situated pretty high up. I understand the gas is all extinguished. The shadows are very dense. The practical result of these lights was, in my judgment, not a success. I will not say it was an entire failure; but I will say this, that if, as a gas-man, I should be called upon to light an area of the same size with gas, and gave no better light than is

produced by these electric machines, it would be voted a failure. Of course, being a new thing, everybody is interested, and people are very lenient in their judgments and criticisms concerning it.

The effect upon the eyes is certainly very trying. Then there is an unpleasant effect produced by the rising and the falling of the light. Sometimes you can read your programme, and other times you cannot do so for a few seconds. Consequently, I consider the result as not a success. Then the effect upon the audience is objectionable. It gives to everybody a ghostly appearance that is not pleasant, especially in a scene of enjoyment. It changes the hues and the colors of the ladies dresses, and, more particularly, the color of their faces. My observations being of a general nature, and directed more especially to general results, I express these views for the sake of informing the Association how far success has been accomplished. Mr. Helme has spoken of one or two other points in Philadelphia where the light is used. There is still another. I do not wish to take the wind out of his sails, as he has some information in regard to it, in connection with myself, in an investigation made on this subject by Mr. Bartol, President of the Washington Company, and several other gentlemen who were similarly interested in the subject. Mr. Bartol, knowing that it had been employed in the works of Messrs. Cranch, iron ship builders at Philadelphia, wrote a letter to them inquiring about it, and he received a letter in reply, from their general superintendent, Mr. Wilson, who is a mechanical engineer of considerable reputation, and a gentleman of large judgment, as everybody who knows him can testify. In what I am going to state I can only speak from information received through others. This firm of ship builders have a large building where they set up the machinery for their steamers and work upon it, and they have tried the electric light in that building. I understand that it was employed in the place of gas, which they had always used before. This little disturbance between Russia and Turkey has thrown a good deal of work into their hands, and they have been obliged to run their works during the night. They were induced to put in an electric light into their shop, and after using it for some time,

I don't know exactly how long, it proved unsatisfactory, as I was informed through a letter received from Mr. Wilson, their superintendent, and its use was discontinued.

Now, from what I have seen and heard of these instances in Philadelphia, and from the observations I have made, and from what I have been told in connection with the experiments that were made at the Franklin Institute, I have looked upon the subject as one *not* very dangerous to the interests of gas companies. As Prof. Morton said last evening, I suppose there are some particular kinds of work for which it may be made available. I take some exceptions to all that has been said and published in regard to its adaptability for street lamps, for the reason that it takes so much power to produce and supply the light that, even were it capable of being divided, its expense would be so great, that, in my judgment, it could not be made available for that purpose. On the general subject I have nothing further to say. I have simply given the Association the results of my observations and my information in regard to what has been done in Philadelphia.

CAPTAIN DRESSER—I would like to say a single word in reference to the heating of the machine. There was a series of experiments conducted in London, and a Siemens machine was put up for the purpose of trying the experiment. The same trouble that Mr. Cartwright has spoken of, in regard to the heating of the machine, presented itself there. Mr. Siemens, the inventor of the machine, was asked in regard to that, and he made this remark: that the machine would, of course, be hot, but that it was perfectly safe to run so long as you could hold your hand on it. When it got so hot you could not hold your hand on it, you had better let up on it. [Laughter]

C. H. NETTLETON—I believe several of the gentlemen who went over to the lecture last night, met Mr. Wallace, and to more than one he made the remark that he considered this a good time to buy gas stocks; and said, turning to me, "you know, I am doing that." Mr. Wallace, as you all know, is probably more deeply interested in the success of this light than any other man in the United States; and when he says

that, it seems to me, we need have very little fear of our future prospects.

Mr. Helme—I think Mr. Price may be able to give us some information on this subject, inasmuch as the Brush machine is made in his town.

Mr. Price—I do not know that I can throw very much light on this question, but I will tell my experience. I was invited one evening to be present at the shops of the Lake Shore Railroad Company, to witness some experiments with the electric lights, that were going to be made there. The lights could not be elevated sufficiently, and the results were not satisfactory, so far as my judgment was concerned, and I don't think it was regarded by anybody but the newspaper reporters as a success. There were exhibitions of the light at some works in our town, but I was not present at either of them; but I am informed that they were not a very great success. It had been proclaimed in the newspapers, however, as a great success. It was exhibited afterward to some persons by special request. The next morning I went up to the works to make some inquiries about it, and I met the president coming out. I knew the gentleman, and tried to talk with him in regard to the electric light. He said, "I don't know much about it, but if you will see our superintendent about it, he can give you the facts," and drove off. I staid there and had an interview with the superintendent, whose name I cannot now remember, but he was a very pleasant and intelligent gentleman, with whom I was acquainted personally, and I found him at his works, and he and the secretary took me to their private office, and we had a long conversation over the recent exhibition. The superintendent said, and the secretary coincided with him, that it had been demonstrated by experience that in building factories, it was not desirable to make the stories more than twelve feet high. That was found to be the most convenient for the elevation of their shaft, and most convenient for the heating of their building. Experience has shown that that is about the right height, but it is too low for the electric light to be used to advantage, and the light was not a success there. He said that the stories of factories would have to be built higher, and therefore involve greater cost of construc-

tion, as building in that way would violate some of the plain rules of economy in the construction of buildings of that character. I went to see the president of a rolling mill there, he is largely interested in the rolling of railroad bars, etc., and he said substantially the same thing. He said that the light would have to be elevated, and that would render additional height necessary; and as these changes would have to be made in factories that were already built, before the electric light could be used to advantage he did not, for that reason, think the light would be very much used.

I am personally acquainted with Mr. Brush. He graduated at our high school, and when I was president of the board of education in our town, I gave him his diploma. I regard him as a very promising young man. He is, perhaps, about thirty years of age, and a good electrician in this department. He is enthusiastic in his work, and I think he believes he has produced the best machine that has yet been devised. He told me that the judgment of a jury of experts had been passed upon his machine, and that it had been pronounced the best machine for producing the light. He told me at the same time he had no expectation that it will affect materially the consumption of gas. He has no idea that it can be so divided that it can be introduced into private houses, and do away with the consumption of gas. He thinks it can be used substantially for the purposes mentioned by Prof. Morton last night, but not for lighting private dwellings, or for the many other purposes for which gas is used.

In regard to its success in this respect, there is a singular contradiction of testimony. The ladies of our town are going to have a loan exhibition for charitable purposes, and, naturally enough, perhaps, they have made me chairman of the committee for lighting the building. It is an old, school building, which has been superseded by a better one. It became a practical question as to how we should light the building. It was suggested that it should be lighted by electricity. So much had been said upon the matter in the papers, that it was thought it would be an additional attraction. I said to the ladies, "do just as you like. If you prefer electricity to gas,

I will try to have electricity. I prefer gas, and I will endeavor to give you a very good quality. We don't care to light your building, for you will probably expect me to give all my attention to it, and all we can make out of it." I told them that there would be a great deal of trouble in lighting the building by electricity, and that we could not guarantee the result. The ladies pretty unanimously said that, as the matter was unsettled, and as there is a possibility of failure if we tried electricity, therefore we had better use gas. And arrangements are being made for lighting it with gas.

Now, while I was discussing this matter, and investigating it, I was informed that the illumination of a building in Philadelphia was a perfect success. I was assured it was so, and I think the person who told me believed it. Mr. Brush also, in substance, told me the same thing. I think he also told me that the illumination of the Mechanics' Fair, at Boston, was a perfect success so far as the Brush machine was concerned, but that so far as the Wallace machine was concerned it was a failure. [Laughter.]

Now I think, as gas men, it is our duty to view this matter in a calm and impartial light. I do not think we should become prejudiced, and listen to all the testimony that favors our view of the question, and reject all the testimony that seems to be unfavorable to it. As gas men, I think we are naturally inclined to disbelieve the testimony that is favorable to electric light, because, we judge, it may interfere with our business. I think we should seek to rise beyond our prejudices, and be entirely fair in our judgments, and be ready to meet the question in its various phases as they are presented to us. If Mr. Edison, or any other man, can succeed in dividing the electric light into 1,000 or 10,000 or 100,000 different lights, and give, at the same time, a clear and satisfactory light, our vocation is gone ; that is, if it can be made as cheaply. Of course, that is one of the principal points. If he cannot do it, of course the light will not supersede gas. I do not apprehend the slightest danger myself—or no essential danger, at least—judging from what has been done. There has been a great deal said, through the press and otherwise, about what Mr.

Edison has done or is going to do. I find there is a great difference of opinion about it. There are a great many people who are enclined to think Mr. Edison is a great genius—that he is abundantly able to accomplish all he has promised. I find, however, that scientific men who have given the subject a great deal of time and thought, have not so much confidence in his ability to accomplish all that he says he is able to do.

I think we are just in the position where we have nothing to do just now. We shall see pretty soon, in all probability, what can be done. For my own part, I do not feel disturbed about the prospects. I think gas stocks are still good enough, and I think it will be a long time before they are interfered with seriously, by electric light.

Mr. Neal—I hold in my hand a paper entitled the *New York Herald*, dated Friday, Oct. 18, 1878. Mr. Harbison objects to my reading from the paper, because it has not been approved and recommended to be read by the Executive Committee; but such action is not necessary in the case of the *New York Herald*, for its statements are always correct. [Laughter.] No one ever knew it to be mistaken, and consequently I feel entirely justified in reading from it. Its reputation for always telling the truth, and always making statements that are perfectly accurate, is so notorious and widespread that I am sure no gentleman present will for a moment think of questioning the truth and accuracy of what I am about to read.

Now, the gentleman last up said that we were not to be guided by our prejudices in this matter, but that we were to listen to the testimony upon both sides of the question. It seems as if, in the course of their remarks, those who have spoken upon the subject, have given testimony somewhat against the practicability of the electric light, and it is pleasant to know that there are some gentlemen here who believe in it, and I have no doubt we should all be very glad to hear from the gentlemen who hold favorable views on that subject. Let us hear what the *New York Herald* says: "Mr. Munzinger, of Philadelphia, said that the electric light was sure to be generally adopted, some day or other." Let us have something on

that side of the question. Of course, everything that is in the *New York Herald* is true.

MR. MUNZINGER—I shall have something to say about that report in the *New York Herald* bye and bye. While we are upon the subject of electric light, I will say that I have made many experiments in connection with it. My first experiments were with 50 cells and an inch copper wire, at a distance of about 300 feet from the battery. I made many attempts to separate the light, but I was not able to do it. I have made a great many experiments with the Gramme machine, and also made experiments at the centennial building, in 1875. We had a Wallace machine, and I think we also had a Brush machine. We had lights placed on the memorial building. It required an engine of about ten-horse power, I think, to produce the light. The light was by no means a satisfactory one. Then we also made later experiments, but we could not get any points that would burn well. We also had lights at the Pennsylvania Railroad Depot, but they were very unsatisfactory. I also made inquiries at Cranch's shipyards, where they had had a machine for producing the light, but I found that they had removed it.

Now, as to the report in the *New York Herald*, I have simply to say, that a young man, whom I suppose now to be a reporter, stood outside of the doors, and wanted to know what I thought of the electric light. I told him there was nothing impossible in this world, apparently, in the way of invention, since you can now stand at one end of the world and talk to a person at the other ; but I told him there was no possibility of the electric light coming into general use. But he has distorted my views, as you see there. The pretended report of what I said is entirely incorrect.

MR. NEAL—It must be so, because it says so in the *New York Herald.*

MR. MUNZINGER—The *New York Herald*, for once, is mistaken. My views are not all correctly expressed. It is a misrepresentation of what I said.

MR. NEAL—I should like to ask Mr. Price if he really thinks that if this electric light should prove to be successful, our

avocation is gone? We are organized for the purpose of furnishing artificial light to the public. A stockholder of the company I represent, wrote me a note the other day, in which he said, among other things, that it would be a good plan, at the next meeting of the Legislature, for the Charlestown company to petition for a change in its name, and that it read as follows: "The Charlestown Gas and Electric Light Company." Now, if the wildest aspirations of Mr. Edison are realized, why cannot we go into the business of producing light by electricity, in connection with making gas? Nobody believes, not even Mr. Edison, I think, that gas will be entirely superseded, because, as I understand it, in order to furnish the light, a machine must be run constantly. The moment the machine stops the light goes out, but gas, as we all know, can be stored. Now, if it is a perfect success, it may supersede gas in many respects, such as the lighting of large buildings, and, possibly, the streets, but it cannot do away with gas entirely. Even if it be a perfect success, why cannot those whose business it is to furnish light to the public, furnish electric light as well as gas light. I do not think that the owners of these patents will go up and down the street, and stop at each house and ask the proprietor to use the electric light, but they will go to these large gas companies—these monopolies, as they are called—and they will make arrangements with them, and if we have the right to sell it, and distribute it to the public, in connection with the manufacture of gas, I see no reason why it should not be made profitable. If it costs five cents to manufacture it, and we pay a royalty of forty-five cents, and charge our consumers a dollar, we will be making a very handsome profit.

Mr. Price—I did not mean to be so understood. We have all heard the extraordinary statements that have been made in regard to what Mr. Edison has done, or can do; and what I meant to say was this, that if all these statements were true in their length and breadth, if the electric light could be produced as cheaply and carried into private houses in the same manner as gas, and if all the other wonderful things can be done that Mr. Edison is represented as being able to do, then our business as gas men is gone, and our capital would be largely affected. It is true, as Mr. Neal suggests, that, if the

electric light could be carried into houses, etc., as has been claimed, then the gas companies might change their business and manufacture electric light in place of gas. The business might be carried on in that way; but it is easy to believe that many difficulties might arise. I think these claims that have been put forth are grossly exaggerated. I do not believe that Mr. Edison set up all the claims, and I do not believe that those who made them were authorized to do so by him. You are aware, gentlemen, of the efforts that have been made for a long time to find something that will illuminate in the place of gas; and the whole scientific world has recently been giving its attention to this question of electric light, and having the whole scientific world at work, trying to accomplish it, it is impossible for us to tell what may be done. But these claims that have been put forth on behalf of Mr. Edison are contrary to all experience thus far. I think the great weight of testimony, on the part of scientific men and learned bodies, is against any likelihood of all these things being accomplished. When I said that our vocation would be gone, I referred to the accomplishment of all these statements that we have seen made in the papers.

Mr. Neal—While these anticipated improvements in electric light are spoken of, is it not as probable that progress will be made in the manufacture and distribution of gas, so that it can be furnished cheaper and its illuminating power be increased.

Mr. Price—There are a great many interesting questions that arise out of the discussion of this subject, and I would be glad if they could be pursued and investigated. I was in the chair when Mr. McIlhenny read his paper upon the organization and the government of gas companies, and did not have an opportunity to make suggestions that I would otherwise have been glad to make. There were a good many interesting questions that arose naturally from the reading of that paper, and I wanted to hear discussion upon the importance of so improving the manufacture of gas, that we could sell it in competition with everything else but sunlight. I wanted very much to come down upon the floor and talk these matters over.

Take for instance a subject suggested by Mr. McIlhenny's paper, viz.: the economical management of gas works. I think this has been very much overlooked in times past. Gas companies, in many instances, have been very reckless in their management. While they have made good profits, and paid large dividends, the details have not been very closely looked after or inquired into. I think it is of the highest importance in our business, that the gas works should be economically and carefully managed, as much so as if they were a private business, conducted by one or two individuals for their own profit. If that is done I think we shall be taking one great step at least towards securing cheaper gas.

There are many other interesting questions that we might properly discuss ; but it is too late now to give them attention. The whole question of how we can manufacture gas cheaper is one which, at the present time, I think, deserves our most careful attention. I think we ought to give more attention to some of these details, when we come together, for the purpose of improving ourselves in the manufacture and distribution of gas. So far as I am personally concerned, I have enjoyed this meeting very much, and it certainly has been a success in all respects, except, perhaps, the one I have just indicated. It seems to me that a discussion of these practical details is what will be of most service to us ; for instance, the best kind of coal to use, the best kind of retorts, the best arrangement for fuel, and, in fact, the whole details of the management of the works.

Mr. Coggshall—Before we adjourn, I wish to say that I think Mr. Price has struck the key-note in regard to what is most profitable to discuss at these meetings ; and I hope that the executive committee will have some paper or papers prepared upon the subject of making gas at the lowest rate. I think we should have one or more papers prepared on the economy of making gas, and upon the utilization of our residual products, so that we can receive a larger compensation for them. I have no fears about the electric light at present, and I think we can profitably turn our attention to the subject of manufacturing gas at a less rate.

Mr. Neal—As the hour fixed for the close of the session has passed, I move that we now adjourn.

The President—Gentlemen : I have listened with all the attention I could give to the matters which have been discussed at this present annual session, and I have listened with the same attention to the papers which have been read before you. These discussions are not regular and formal orations, but are more in the nature of conversations, where one gentleman gives his own experience, and then asks the experience of others, and answers questions which may be proposed. All this discussion, all these questions and these answers tend to attain the object which has been spoken of to-day, viz : how best we can conduct our business, and how we can produce the most acceptable light at the least possible rate.

In the years gone by, we have had discussions over and over again, as to the best methods of setting retorts, and the best method of purifying and condensing gas. These are subjects which are constantly presented to us, in the paper which is now the official organ of this Association, the *American Gas Light Journal*, published in this city, one of the most valuable scientific papers of the day, and edited with consummate ability. [Applause.]

Some jesting has been indulged in to-day in connection with the *New York Herald*. The *New York Herald* is accustomed to crack its joke, even at the expense of truth, and even though honest and worthy men may suffer. [Applause.] Other papers have seemed to take pleasure in speaking in a manner particularly harsh, of plumbers, gas-fitters and other honest mechanics, just as though a mechanic must necessarily be as devoid of principle as a newspaper. [Applause.]

Now, gentlemen, you have heard much in your conversations together, informally, at your boarding-houses and hotels, which will be of service to you, I doubt not. Carry the lessons you have learned, home with you, and use them in your profession wisely and honestly ; for, if there ever was an honest profession on God's earth, it is the profession in which we are engaged ; and if there is any article in the market known to commercial men, which is sold with more accuracy and exactness than the

product we manufacture, I do not know what it is. It is a very common thing for the editors of newspapers to throw dirt at gas companies and gas managers. They even go so far as to say that consumers pay just what we please to charge, without reference to the amount of gas consumed; that no one knows whether the meters we use are honest or not, and that we say to the consumer, "You must pay for what the instrument shows you have used, or we will deprive you of the gas." Where do we buy our meters? We buy them of honest mechanics, and besides that, no meter can be put in use that is not tested by a public officer, appointed by the Governor, under authority of law. We have no control over that matter. We are compelled, under penalty, to use an article which the law says we shall use, and if there is anything in our business, as men and engineers, that we ought to understand, it is the construction of a meter, which we are compelled to use, whether we want to or not.

Gentlemen, it is a slander upon us when the papers come out and represent us as dishonest. It is a slander upon us when they call us monopolies. Why, in this very district where this meeting is being held, there are three competing gas companies. Where is the monopoly, then? Surely not here.

We know that we are entitled to receive the respect and confidence of the public at large. We know that our business is conducted in an honest and impartial manner. The manufacture of gas is reduced to a question of pure science. Learned chemists and skillful engineers have devoted years of patient study and toil to the solution of the various problems that have presented themselves in the development of the science. Are their reputations to be assailed and their good names tarnished by every penny-a-liner, or would-be wit? Any man can throw mud. No character is so safe that it cannot be stained by the malice, or the ignorance, or the bad feeling of those who do not know what they are talking about. [Applause.]

We are about to separate. We are going to our homes from the Canadian to the Mexican lines, and from the Atlantic to the Pacific oceans. Let us maintain the dignity of our profession, and resent any insult cast upon our integrity. [Applause.]

I wish you, brethren, a pleasant journey home. I sincerely

hope it may be my good fortune to meet you another year, and that the year upon which we have just entered will witness constant improvements in our business. We have no secrets from each other. Our works are open to all—not only to those who are engaged in the business, but to the public at large. We have no secrets that any honest man would wish to guard.

I bid you, respectfully and affectionately, farewell, and declare this annual meeting of the Association adjourned *sine die*. [Applause.]

LECTURE UPON THE ELECTRIC LIGHT.

Delivered Oct. 17th, 1878, before the Americrn Gas-Light Association

9 By Prof. HENRY MORTON, Ph. D.,

Pres. Stevens Inst, Hoboken, N. J.

Gentlemen of the Gas-Light Association :—I purpose this evening to show you what the electric light now is in the various forms in which it has been developed up to the present time, and also to give some account of its history, and to point out, from a study of the latter, what are the reasonable prospects of its future development.

In the first place, evidently an electric light is some source of light developed by electricity, and as there are three distinct methods by which electricity may be caused to develop light, we have naturally three distinct sorts of electric light.

Naming these in the order of their intensity, they are—

The Electric Arc,

Ignited Conductors,

Incandescent Gases.

These I will show you, and explain in their order.

The electric arc may be said to have made its first appearance on this planet in the laboratory of the Royal Institution, in London, when Sir Humphrey Davy, in 1808, made his famous experiments with the galvanic battery of two thousand pair of plates, with which he decomposed soda, potash, etc., and discovered their metallic bases.

The experiments of Davy were repeated and extended by various continental investigators, and in this country by the elder Siliman, of Yale, who first noticed and described many of the characteristic phenomena of this electric discharge, or "Voltaic arc," as it is called.

Its image was first projected on a screen by Foucault, and "electric lamps" or regulators were, at an early period, devised

by him, by Deleuil, by Duboscq, and by many others; and efforts to improve these in the way of rendering them more efficient in producing a reliable and steady light, have continued down to the present day, and are by no means at an end now.

THE ELECTRIC ARC.

FIG. 1.

In order to understand these, it will be necessary to consider a little what this "electric light," "electric arc," or "electric discharge," is, or consists in.

When two pieces of dense charcoal, retort carbon, or the like, are connected, each with one pole of a galvanic battery, consisting of fifty or more pairs of plates powerfully excited, and, after being brought into close contact, are slightly separated, a stream of electric fluid, as we call it, rushes from the positive to the negative pole, carrying with it particles of the carbon, as well as filling the space between with vapor of the same. The particles thus torn off are exceedingly heated by this action, as also are both the poles between which they fly, so that all becomes intensely luminous. The intensely hot and luminous poles constitute the "electric light" of this form.

I now cause the image of the electric arc to be projected upon the screen, and you there see (Fig. 1) what I have described. If we place a piece of silver in a carbon cup, arranged as the positive pole, it is, as you see, instantly fused into a luminous white-hot globule, from which springs a tongue of emerald green flame, and also a cloud of silver smoke, or vaporized silver, forming a swaying curtain or veil around the brightly luminous globule and negative pole of carbon.

Beautiful and intense as is this electric arc, it is evident that, in order to become useful, it must be rendered constant and uniform in its action.

Now, to render this electric arc in any degree constant and reliable, a variety of conditions must be provided for.

Thus, in the first place, as I have already noticed, a part of the carbon is actually vaporized. This causes a wearing away of the poles. Again, the carrying of particles of carbon from one pole to another changes the form of each. If the action goes on in the air, there will also be an actual combustion of the carbon poles. To counteract these sources of irregularity regulators of various sorts, operated by clock-work or by gravity, and controlled by the current and the consumption of the carbons, have been devised by Duboscq, by Foucault, by Gaiffe, by Serrin, by Deleuil, and many others.

The difficulty with all these, is that, however well they may regulate everything else, they cannot regulate the minute accidental variations in the structure of the carbon poles during their consumption, by reason of which these sometimes become

very thin near their extremities, which diminishes the amount of light produced, and at others change their shape so as to allow the main discharge to pass more to one side than another, so shifting the source of light from side to side of the poles, the side furthest from the discharge always emitting much less light, and being shaded by the pole itself from the greater light produced on the other side.

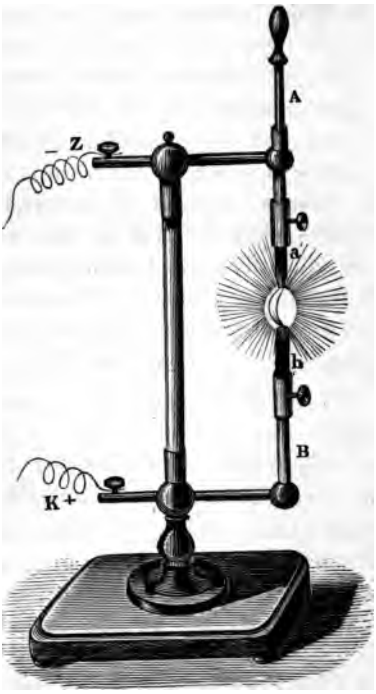


FIG. 2.

Thus, for example, with an electric arc, springing, as shown in the cut Fig. 2, from the left side of the poles, a b, many times as much light will be emitted towards the left as will come towards the right, and as the arc flies around, this direction of maximum of emission will, of course, change with it.

So immense are the fluctuations produced in this way that, in the experiments which I have myself made, I found the

same light, measured from a given direction, to change, within a few minutes, back and forth between 400 and 2,000 candles.

The use of reflectors and shades tends to equalize these irregularities, but they are present, to a marked degree, in all arrangements which have ever come under the notice of the present writer, notwithstanding the contrary assertions of all their respective inventors or promoters. Thus, only a few days after I had first noticed the electric lights used in the basement hall of the Equitable Building, and had remarked their exceptional irregularity, I saw in one of our mechanical journals a long article on the very regulator there used, describing it as *the* successful solution of the problem of a perfectly steady electric light. Again, a few days since I was visited, within a few hours, by one of the prominent promoters of electric lights, who described to me the universal satisfaction expressed by every one with *his* regulators; and by one of our largest mill owners, who was anxious to introduce electric lights into his mills, but having examined *this same* light in a place where a number were in constant use, found that *that* regulator, at all events, was entirely too unsteady to answer.

All things, of course, have their degrees, and there are undoubtedly numberless places where the best regulators are quite steady enough to do all that is required. But certainly the problem of an electric light *steady* enough for *all* uses has not as yet reached a solution in the direction of what are known as " electric light regulators."

Many years ago elaborate experiments were made to overcome this difficulty by employing a stream of mercury, falling in successive drops from one reservoir to another, as the source of the electric light. This was known as the Way light, and extensive experiments, with massive and costly apparatus. were carried on to test its efficiency. The volatilization and oxidation of the mercury, the want of constancy in the light, and other like causes, however, led to the abandonment of these experiments, after a large sum had been expended.

To dispense with the costly machinery of these mechanical regulators, M. Jablochkoff has recently carried out the ingenious plan of making a sort of electric candle, in which two

parallel rods of carbon, separated by a narrow band of fusible porcelain, are supported vertically and made the poles of an electric circuit. The current, leaping between their ends, melts down the barrier of porcelain as the rods are consumed, and thus the "candle" burns down. This arrangement has, without doubt, the merit of simplicity, but it has found little favor in this country, because it has proved to be less reliable than the "mechanical lamps" or "regulators," and to involve a great waste of power, expended in overcoming the resistance of the interposed porcelain.

In this department of electric lighting, the case stands, I believe, at the present day, thus :—Improvements in electro-motors (that is, machines for producing electricity, of which we shall speak further on) have given us relatively cheap electricity, obtainable with convenience wherever steam power is at hand ; but the electric light regulators of to-day are not essentially different from, though much in advance of those of fifty years ago ; and, while they will furnish a light reliable enough and steady enough for a vast number of uses, they are by no means fit for universal application, nor does the progress which they have made in the direction of improved steadiness hold out any strong encouragement to hope that much more can be done in this direction, unless some radically different method can be discovered.

The question of economy, efficiency, and practical application of the "electric arc," as a source of illumination, as well as the proper basis of measurement by which to determine its actual performance, I will discuss further on after we have considered other departments of the subject which must be included in such consideration.

We will turn now, therefore, to the next form of electric light—that mainly produced by

INCANDESCENT CONDUCTORS.

In some of the early experiments of Sir Humphrey Davy, we find mention of the heating to luminosity of wires of various metals, as tests of the comparative power of different batteries; and, in 1858, so great an advance had been made in the prac-

tical utilization of this means of lighting, that M. Jobart, in a report to the Academy of Sciences in Paris, was able to speak as follows:

"I hasten to announce to the Academy the important discovery of the dividing of an electric current for lighting purposes. This current, from a single source, traverses as many wires as may be desired, and gives a series of light ranging from a night lamp to a lighthouse lamp.

"The luminous arc between the carbons produces, as is well known, a very intense, flickering, and costly light. M. de Changy, who is a chemist, mechanician, and physicist, is thoroughly conversant with the latest discoveries, and has just solved the problem of dividing the electric light.

"In his laboratory, where he has worked alone for the past six years, I saw a battery of twelve Bunsen elements producing a constant luminous arc between two carbons, in a regulator of his own invention—this regulator being the most simple and perfect I have ever seen. A dozen small miner's lamps were also in the circuit, and he could, at pleasure, light or extinguish either one or the other, or all together, without diminishing or increasing the intensity of the light through the extinction of the neighboring lamps. The lamps, which are enclosed in hermetically-sealed glass tubes, are intended for the lighting of mines in which there is a fire-damp, and for the street lamps, which would by this system be all lighted or put out at the same time, on the circuits being opened or closed. The light is as white and pure as Gillard's gas, with which it has one point in common, namely, its production by the incandescence of platinum. The gas pipes are replaced by simple wires, and no explosions, bad smells, or fires can take place.

"The trials that have been hitherto made, with the object of producing an electric light by means of heated platinum, have failed on account of the melting of the wires. This difficulty has been overcome by M. de Changy's dividing regulator. The cost of the light is estimated to be half that of gas. A lamp placed at the mast head of a ship would form a permanent signal for about six months without the necessity of changing the platinum. With several such lights, placed in

tubes of colored glass, it would be easy to telegraph by night, as they could be extinguished and relighted rapidly from the deck.

"For lighthouse purposes considerable amplitude can be given to the light. I also saw a lamp so arranged, in a thick glass globe, that it could be immersed to considerable depths without being extinguished by any movement. This lamp has already been used in the taking of fish, which were attracted towards the light.

"The above slight description will suffice to show to what a variety of applications this discovery can be put. The communication which I have had the honor of laying before the Academy is founded upon no illusion; a lamp was, to my astonishment, lit in the hollow of my hand, and remained alight after I had put it in my pocket with my handkerchief over it."

In looking the matter up in the *Comptes Rendus*, or minutes of the French Academy, I find that the communication of M. Jobart was received at the meeting held March 1st, 1858, and was referred to M. Becquerel. At the meeting of April 5th, M. Becquerel reported that he did not find anything sufficiently definite to warrant the Academy to express an opinion as to the importance of this discovery. "All that was desirable at present was fuller information." At the meeting of April 19th M. Jobart responds to this request by stating that "he could not give more precise details without exposing the author to see another, profit by his discovery."

Familiar as is the fact that history repeats itself, we cannot but be struck by the many points of resemblance between the above and what we read in the newspapers of to-day, concerning the wonderful doings at Menlo Park, and must hope that Mr. Edison's inventions will escape that permanent obscuration which seems to have finally shrouded M. de Changy's.

It would appear as if this brilliant and complete success described by M. Jobart as achieved by M. de Changy in Paris, in February, 1858, was very rapidly followed up in this country, for I learn from a letter in the *Salem Observer* of Nov. 2, 1868, that Mr. Moses G. Farmer, in Salem, lit his parlor every

evening during July of 1859 with electric lamps operated on a like principle.

It is true that nineteen years have not sufficed to render this admirable arrangement successful in practice, but what is that to the prophetic mind which, foreseeing what is to happen in the "near future," naturally overleaps distinctions between past and future, theory and practice.

For us, however, who only know the past and the present, it may be well to look a little closer at the means actually used, and the results obtained, in these and other experiments.

In the first place, let me show you what this light by incandescence actually is.

There is a coil of platinum wire, through which I pass the current from a battery. It grows first red, then yellow, then white, and now it gives out a beautiful soft and steady light; but we must be cautious; if I allow the current to become a little stronger, the wire fuses and drops asunder, and our experiment is at an end.

It is, as I understand, just here that Mr. Edison has made his much announced but carefully concealed invention. He has devised some simple and ingenious arrangement by which the solid conductor can be brought up to the highest point of incandescence, without risk of fusion.

True, this achievement was claimed for M. de Changy, and seems to be implied in Mr. Farmer's description; but somehow, as with the famous perpetual motion machine, "the little screw which makes it all go" does not appear to have been forthcoming in either case; and in this present year of 1878 we still look to the "future," "near" or remote, for the "practical success" so confidently announced nineteen or twenty years ago.

The first electric lamp operating by incandescence of which we have any actual record seems to be that invented by the American, Starr, a patent for which was taken out in England by his agent, King, in 1845, and which has thus come to be known as the King lamp. This lamp has been modified in details until it has reached the form shown in Fig. 3, known as the King lamp.

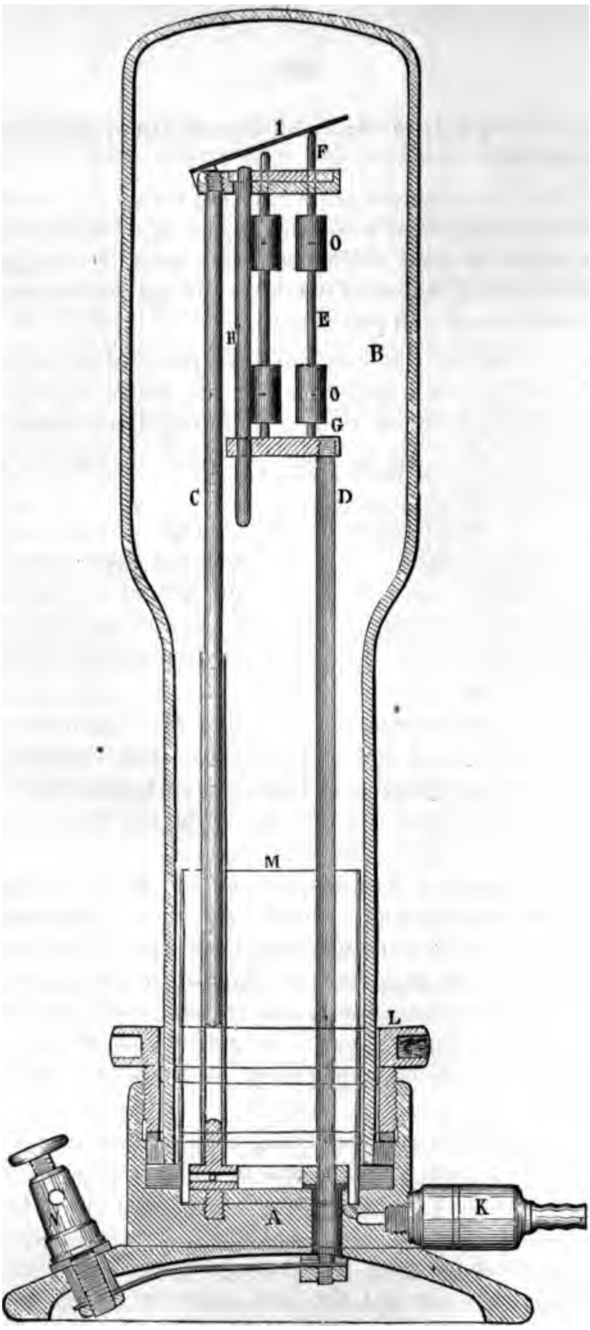


FIG. 3.

This apparatus consists of a glass vessel provided with a metal cap and packing box below, by means of which it can be closed air-tight.

A connector at K allows of the exhaustion of air from the interior, and the filling of the interior with any inactive gas.

Two upright metallic conductors, connected respectively with the two poles of the electric circuit, pass up through this glass vessel and at their upper ends support, as shown, two or more rods of carbon or other conductors. The electric connection with these rods is made from C by means of the lever I, which communicates first with the longest rod, F, and when that is burned up, falls upon the next longest, and so on. The light is produced by the rod of carbon heated white hot by the current.

Various slight modifications of this lamp have been made and elaborately experimented with ; but they all show the same essential characteristics. The first of these, is, that as long as any oxygen remains in the vessel, the carbon rods consume rapidly, the first one generally lasting only twenty minutes. The second carbon will, however, last two hours if the light does not exceed forty burners ; but even when all active gas has been removed, the carbon suffers a sort of vaporization.

The second characteristic of these incandescent lamps, is, that with the same current, they develop much less light than is obtained from the electric arc. Thus, a battery of 48 elements, with a Serrin lamp, gave an electric arc equal to 100 burners; but with one of these lamps, gave a light equal only to 80 burners, and when divided between three lamps, gave only the light of 10 burners each.

The third characteristic is the manner in which the light-producing power of the current diminishes, as it is distributed between a number of lamps. Thus, the current from a given battery, acting on one lamp, produced a light between 4 and 5 burners ; on two lamps, a light 1½ burners each ; on three lamps, one-third to two-thirds of a burner each. From another battery, the current on a single lamp gave a light of 11 to 12 burners ; with two lamps, one-half burner each ; and on three lamps, one-ninth of a burner each.

In another case a given battery with one lamp gave the light of 9 burners; with two lamps, 2½ burners; and with three lamps, one-third of a burner each. Another battery with one lamp gave a light of 65 burners; with two lamps, 7½ burners; with three lamps, 1⅓ burners; with four lamps, three-fourths of a burner; and with five lamps, one-half burner each.

In this connection it is curious to notice that the latest accounts from Mr. Edison show that he gets a light equal to about 48 candles, or three argand gas burners, per horse power with his new device, and with similar machines for producing the electric current and the electric arc, from 1,000 to 2,000 candles per horse power; thus showing remarkable agreement with these earlier experiments as to the loss of effect resulting from the subdivision of the light.

Another modification of this Starr, or King lamp, is found in that which has been recently exhibited in New York as the Sawyer-Mann lamp.

This differs from the former apparatus in no important feature except that the interior of the vessel is said to be filled with pure nitrogen at the ordinary pressure. The carbon rods are said not to waste away in these lamps. Without knowing anything positively on the subject, my opinion is that this is simply because they have not been subjected to strong currents, but have only been heated to the extent of yielding the light of one or two burners. Under these circumstances, the carbons of the King lamp will last a long time, but on the other hand, the light so obtained is not economical, as we see above.

When exhibited in New York recently, we understood that five lamps only were operated by a magneto machine of Arnoux & Hochhausen, driven by a three-horse power steam engine, said to be developing only one and one-half horse power.

It is certain that none of these lamps have yet demonstrated anything like such practical success as can enable us to see that they can take the place of gas in ordinary illumination. They have, of course, many advantages in certain respects over the electric arc, but these are combined with compensat-

ing drawbacks on the part of economy; and it is only by turning our eyes to the as yet *unrevealed possibilities of the future* that we are able to see the electric light as *a successful substitute for gas and other methods of illumination.*

Another method of electric illumination by ignition is that suggested by Jablochkoff some time since, but which seems to have been abandoned practically on account of the costliness of the apparatus, not to mention other difficulties.

This consists in causing the main current to pass in a series of intercepted, or reversed pulses, through the primary circuits of numerous induction coils, and then to pass the induced sparks, obtained from the secondary coils of these instruments, across or around little rods of porcelain, which thus become heated to whiteness.

Fully to understand this it will, however, be necessary to explain the structure and operation of an "induction coil," and this comes naturally now in order in connection with the third method of obtaining light from electricity, namely,

ELECTRIC LIGHT FROM INCANDESCENT GAS.

In order to obtain electricity in such a state that it will pass through a gas and thus heat it to luminosity, we must, in practice, make use of an induction coil.

One of these instruments is shown in Fig. 4, as seen outside,

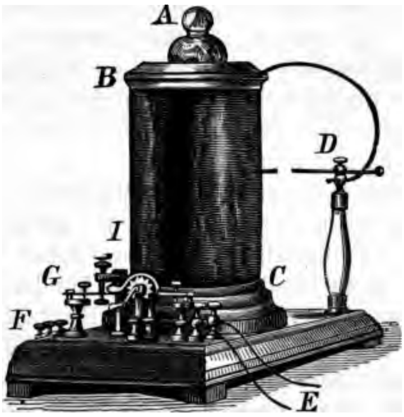


FIG. 4.

and in section in Fig. 5; its structure and mode of operation may be described as follows:

Beginning from the interior of the structure, we have in the first place a core A, B, formed of a bundle of soft iron wires. This is surrounded by a coil of thick copper wire so arranged

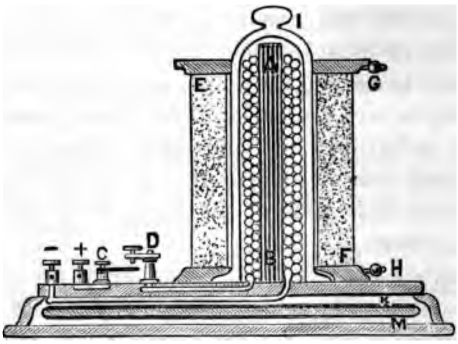


FIG. 5.

that an intermittent current of electricity from a galvanic battery may be passed through it. This interruption is affected as follows: The current from the battery enters at the binding screw and passes by a brass strip to the column C, and thence to the brass spring, which rests against the screw D, thence by the column D into the coil indicated in section around A B, and out again to the battery by the binding screw. When the current is to be interrupted, a hammer, omitted in the figure, falls upon the spring between C and D, so striking it away from screw D. When the current passes, it powerfully magnetizes the core and when it ceases, the core rapidly (we may say instantly) loses its magnetic properties.

Outside of this coil, thus carrying the battery current, and which is known as the "primary coil," or "primary circuit," is another coil, E F, usually of very fine copper wire of great length, varying from hundreds of feet to hundreds of miles in different instruments. This is known as the "secondary coil," or "secondary circuit," and in *it* is produced, by magneto-dynamic induction, a momentary current at the instant when the iron wires of the core become magnetic, and another momentary current in an opposite direction, at the moment when the

core loses its magnetism. This gaining and losing of magnetism is, of course, the result of the passing and stopping of the primary current, and thus, in this sense, the secondary or induced current is caused by the primary one. If, in place of simply interrupting the primary current, as above, rapidly alternating currents, in opposite directions, are sent through the primary coil, the practical result will be the same. These momentary induced or secondary currents have, as we say, high intensity, being able to leap over distances, and pass through resisting materials.

Thus, the coil shown in Fig. 6, constructed some years ago for the present writer, and which contains, in its outer or secondary coil, 50 miles of wire, will throw a spark 21 inches through air, or, through a block of solid glass, three inches

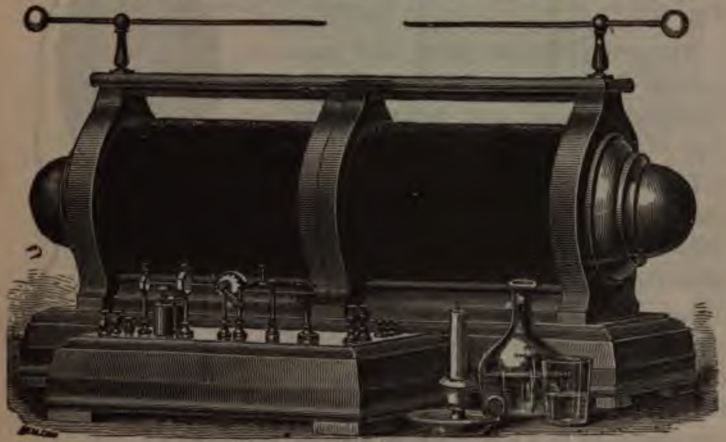


FIG. 6.

thick. These instruments are, however, on account of the amount of wire used, and the careful insulation needed, very expensive. Thus, the one shown in Fig. 4, cost $275, and that shown in Fig. 6, $1,000. To employ one of them wherever a single gas burner was to be replaced, would, therefore, be out of the question, on this ground of cost, without considering any other objection.

This same discharge from an induction coil, may also be used as a source of light in another way.

If an exhausted vessel, or one only containing highly rarefied gas, is arranged with conductors running into it, as in Fig. 7, and these conductors are connected by wires with the ends of the secondary of an induction coil, then the electricity will pass through the rarefied gas, producing light which will be often arranged in strata, or layers, in the manner indicated in the drawing, Fig. 7.

If the cross section of the vessel is smaller, the light is brighter, and thus, by the use of tubes with wire let into them, very brilliant effects can be produced. Such tubes are called, from their first manufacturer, a glass blower of Bonn, Geissler tubes, and some of the ordinary forms are shown in Fig. 8.

By using different gases, and employing various fluorescent substances, in the surrounding jackets, very beautiful combinations of colored light are obtained.

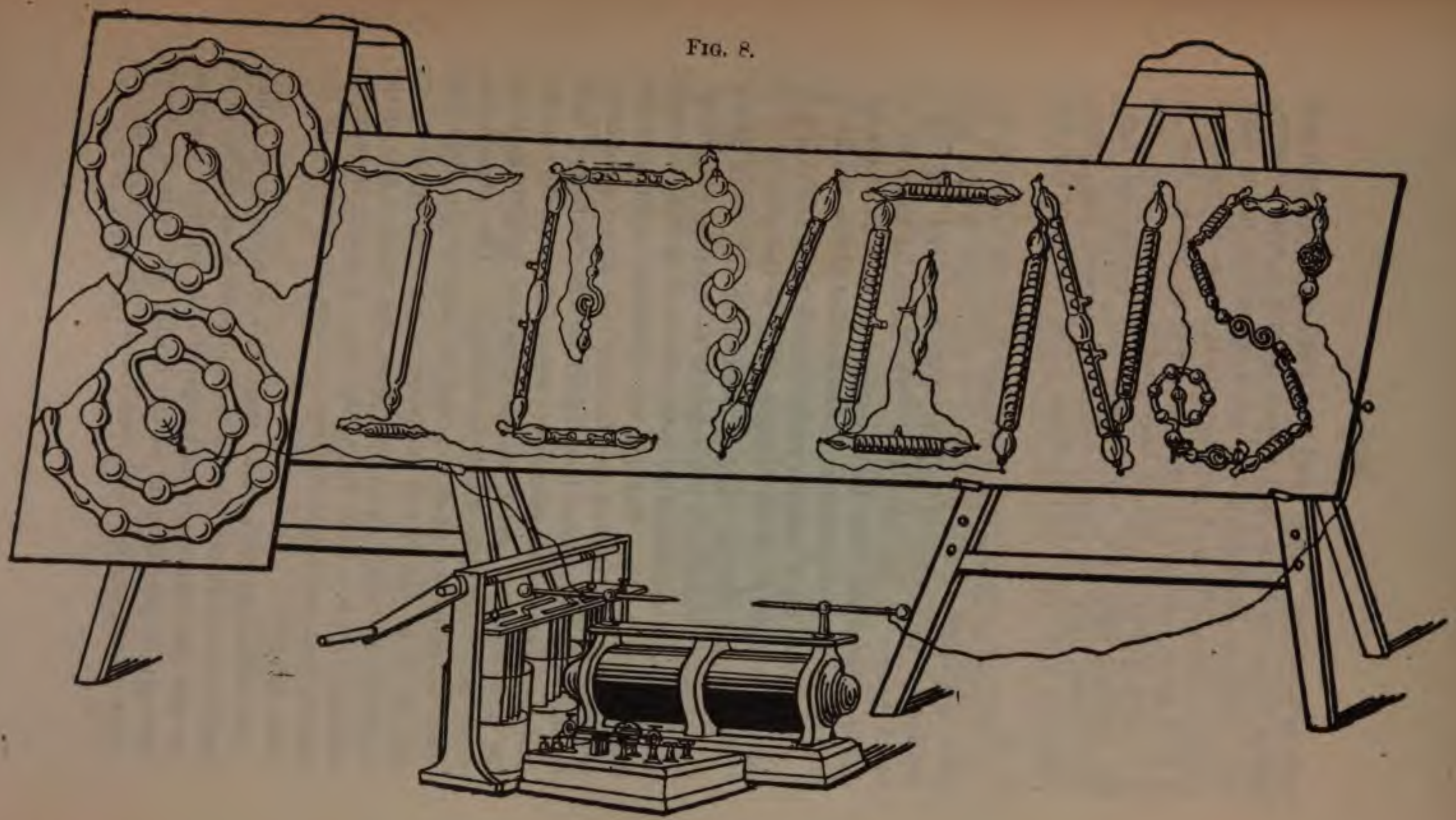
I now show you (Fig. 8), a number of these tubes arranged on a screen, and illuminated at once by the discharge from my large coil.

Some of these tubes you will notice not only emit a bright light while the electric discharge is passing, but continue to glow for some minutes after it has ceased. This introduces us to a new phenomenon of light.

FIG. 7.

When light falls upon certain bodies its vibrations cause changes in the relative positions of their particles, somewhat like the changes which heat vibrations produce in solids when they cause them to melt; for example, ice melted by the sun's rays. When, however, these vibrations cease to act, the changed substance falls back into its previous condition (as when the melted ice again congeals), but in so doing, emits again vibrations like those expended in the former change, but of lower "pitch," or greater wave-length. Just as water in freezing

FIG. 8.



emits heat, of low "pitch," and thus cold, compared with our bodies, but nevertheless heat compared with a zero temperature. So these phosphorescent bodies exposed to strong light suffer a change which, in reversing itself, causes the emission of light again, fainter, it is true, and lower in "pitch," that is, of a color nearer the red or lower end of the spectrum, than the exciting light, but nevertheless very appreciable light. Thus violet light, by phosphorescence, becomes blue, green, yellow, or red; blue light becomes green, yellow, or red, and so on.

Such gases as are contained in these tubes are, however, not alone in possessing this property. I have here several solid substances—sulphides of barium, strontium, and calcium—which behave in the same way. We illuminate them by an electric spark, and then they continue to glow in the dark. Superior to them all, however, I find the dial of this clock.

I expose it for a moment to the electric light, and now you see it in the dark from the furthest corner of the hall.

I have analyzed the material with which this clock dial is coated, and I find that it is a sulphide of calcium ("Canton's phosphorous," discovered in 1768), attached by some resinous medium or varnish. Though the substance is therefore in composition, only the old and familiar one above mentioned, its present manufacturers have found out some method of wonderfully increasing its efficiency. One of these clocks exposed for a moment to direct sunlight glows so brightly as to be easily seen in a room which is darkened. This phosphorescence is, moreover, readily excited by lamp or gas light, and one of these clocks will continue to glow during an entire night with no other excitement than that which it gets by the diffused light in a room during the day. Towards morning the glow is faint, but is still sufficient to show the position of the clock hands.

The substance required to make this compound—*i. e.*, lime and sulphur—are very cheap, and the French savant, Becquerel, who has elaborately investigated this subject, describes methods of preparing it so that it shall emit light of various colors—orange, green, blue, and violet. If a further advance

in brilliancy and duration should be made at all equal to that shown by the clock dials as compared with all former specimens, it is not improbable that this may become a very important substance. If we could paint our walls with such a body, it would, as it were, absorb light during the day and then emit it during the night, and it would only be necessary to have curtains to draw over our luminous walls at night to shut out their light when necessary, just as we now draw curtains over our windows in the day time.

In face of such an arrangement as this, even Mr. Edison's new "electric burner" would be costly and unnecessary. By painting the outside of houses with the same material, all need of street lamps would be avoided.

It is true that "some practical difficulties remain to be overcome," but what are those in these days of inventive power? Should one of our great inventors take the matter in hand and organize a stock company, it will, of course, be merely a question of time and expense in preliminary experiments.

Seriously, however, this new form of phosphorescent sulphide of calcium is a wonderful substance, which may well suggest strange possibilities for the future.

ELECTRO-MOTORS, OR INSTRUMENTS FOR PRODUCING ELECTRIC CURRENTS.

In whatever way electricity is to be used as a source of light, there is, of course, no question that a cheap source must be found in order that it may compete with other sources of illumination. As long as the galvanic battery was the only source of electricity, we were met at the very start by the following state of facts:

The source of energy in the battery is practically the zinc consumed. Weight for weight, coal has almost six times the available energy of zinc; while, moreover, the price of zinc is 25 times that of coal. In the race between the two, therefore, zinc starts with this enormous disadvantage that an equal amount of energy obtained from it will cost about 150 times as much as if obtained from coal. To make gas from coal, and

burn it for light will then be cheaper than to obtain electricity from zinc and turn it into light, unless the loss in the former case is 150 times greater than in the latter.

Batteries, therefore, as sources of electric force for lighting purposes, are out of the question from an economic standpoint.

The possibility of economic lighting by electricity came first to exist when, in 1831, Faraday discovered that the motion of a magnet in relation to a conductor would develop a current of electricity in the latter, and thus that electricity might be developed by the expenditure of mere mechanical energy.

Then, to the coal distilled in the retort was born as a rival (as yet helpless as an infant and unknown), the coal burned under the boiler of the steam engine.

This child has grown slowly or rapidly ever since, and if the reign of the *gas coal* is to end, it will be only to its near relation, the *steam coal*, that it will yield its throne.

It is therefore eminently proper that we should trace the progress of this development in the present connection.

The first principle involved in this subject is this :—

Magnets exert forces in all directions around them, but in such a way that they may be said to be surrounded by "fields of force," in which the forces are distributed in certain directions, known as "lines of force." Some notion of these is obtained if we place a plate of glass over a magnet and then sprinkle iron filings on the former, when on tapping the glass the filings will arrange themselves in certain lines.

A very beautiful method of arranging and permanently fixing such lines has been devised by Prof. A. M. Mayer, and from a plate so arranged by him Fig. 9 has been produced by a process of photographic engraving.

Now it was discovered by Faraday, in effect, that whenever a conductor was so moved in the vicinity of a magnet as to pass through or "cut" these lines of force, a current was developed in the conductor. The greatest effect was obtained when the lines were cut at right angles, and when the greatest number of lines are cut in the same time, either by passing through a denser "field of force" as near the poles of the mag-

FIG. 9.

net, or by moving more rapidly. When the conductor moved *along* the lines of force no current was produced.

As the conductor passed into and through the "field" of one pole a current was developed in one direction, and as it passed out of the same field into and through the field of the other pole, a current in the opposite direction was developed. Between the two fields there would, of course, be a neutral point where no current was developed. Indeed, if we turn to Fig. 9 we will see that a conductor, while passing the centre of the magnet, would be moving along the lines of force, and ought, therefore to develop no current, while near the poles it would pass at right angles to the lines of force, and so give a maximum current. At other parts of its path the conductor develops currents of more or less intensity, according as it finds the lines of force more or less oblique to its path.

While the above basis of explanation is very commonly employed in connection with our present subject, it does not seem to me as satisfactory, nor as clear and direct in its relations to the entire subject of electrical induction, as another which I shall now proceed to state.

In the first place, it will be desirable to state the relations between magnets and electric currents first pointed out by Ampere.

According to his theory, a magnet owes its characteristic properties to the presence in the molecules of electric currents all circulating in the same direction.

In other words, if Fig. 10 is supposed to represent a short magnetic bar with its south end toward us, the little arrows would represent the direction in which the currents of positive electricity were flowing in its molecules.

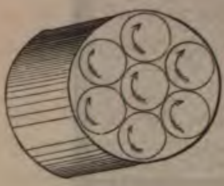


FIG. 10.

FIG. 11.

FIG. 12.

The general effect of such currents could evidently be expressed by single currents passing in the entire bar, as indicated in Fig. 11, and the practical effect of such a series of parallel currents would very evidently coincide with that of a current passing through a helix, as indicated in Fig. 12.

As a matter of fact, we find that a helix of wire, through which an electric current is flowing, will exhibit all the properties characteristic of a magnet. Thus, it will attract iron,—if freely suspended will point north and south, and if two such helices are brought together their like ends will repel and their unlike ends attract each other.

This attraction and repulsion, moreover, appears to come under a still wider law, for it may be readily shown that any parallel electric currents, if going the same way attract, and if going the opposite ways repel.

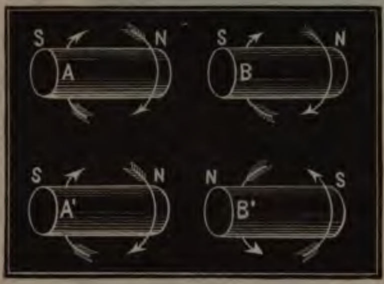


FIG. 13.

Fig. 13 shows how this explains the attraction of unlike and repulsion of like poles in magnets.

In A and B, the north and south poles being opposite, the magnetic or electric currents flow parallel and in the same direction, and thus attract in A′ and B′, the two north poles being together, the currents flow in opposite directions, and thus repel.

Another general law must next be stated, namely : Whenever a conductor approaches a parallel current, a momentary flow of electricity is established in the said conductor, opposite in direction to that of the current towards which it is

moving; as the same conductor recedes from the current a momentary flow in an opposite direction is produced.

Let us see how this applies in such a case as we have now to consider.

Let NS, Fig. 14, represent a magnet in which the magnetic currents are flowing as indicated by the arrows on the bar; if, then, we bring a conductor, like the loop of wire to the right, towards the south end of this magnet, a current will be developed in the loop opposite to the currents in the magnet, be-

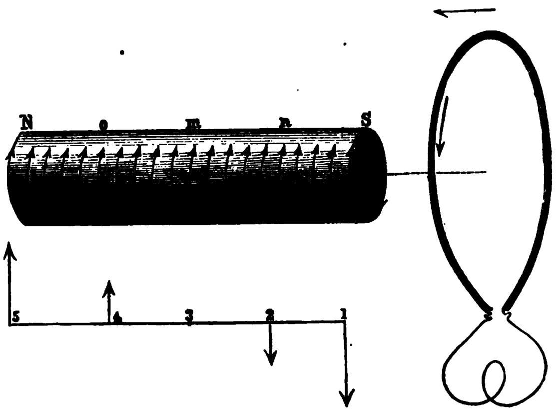


FIG. 14.

cause the loop is approaching all of them. If now the loop continues to be moved forward over the S end of the magnet, when it comes over, say the point N, it will still be approaching many of the magnetic currents, but will be receding from a few, those, namely, which it has already passed. There will, therefore, be an interference between the opposite currents due to the approach to the magnetic currents to the left, and the recession from those to the right, and the resulting current will, therefore, be feeble, although still in the first direction.

When, however, the loop comes over in the number of magnetic currents it is leaving, is just equal to that of those it is approaching, and the two currents will, therefore, be exactly neutralized.

Beyond m, towards N, however, the current due to the with-

drawal from the magnetic currents will predominate and increase until the North end of the magnet is passed.

The horizontal lines with vertical arrows, at the lower part of Fig. 14, represent the directions and relative intensities of the currents developed as the loop moves over the magnet from right to left.

It will be readily understood that it is quite immaterial whether the conductor is moved over the magnet or the magnet is moved through the conductor.

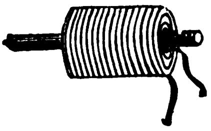


FIG. 15.

Thus, if the conductor is wound into a coil, as in Fig. 15, and the magnet is pushed into or drawn out of it, we shall have a like production of currents. Or again, if the coil should have in its centre a bar of soft iron, and this should be magnetized by the approach of a magnet, and then lose its magnatism on the withdrawal of the same, this will be equivalent in effect to the sudden insertion and withdrawal of a magnet.

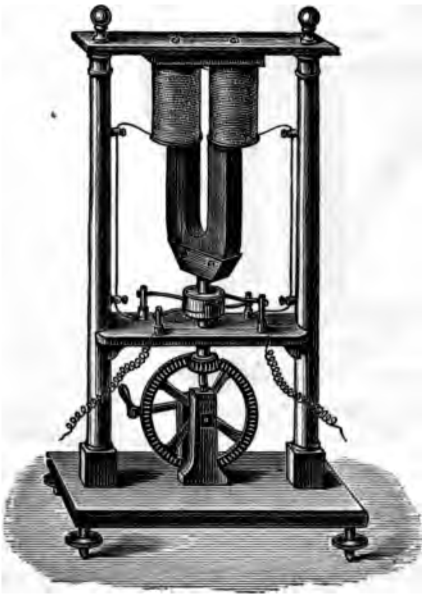


FIG. 16.

The first attempt which was made to utilize the above-described principles, in producing a current of electricity from a magnet, by the expenditure of mechanical energy, was that by Pixii, of Paris, who, in 1832, produced the apparatus shown in Fig. 16.

Here two coils of wire, with soft iron cores, are supported at the upper part of a frame, while below them a strong steel magnet is made to rotate by appropriate machinery. As each pole of the magnet in turn comes opposite the iron core of either coil, it renders it instantly magnetic, and thus developes a current in the surrounding coil. These currents, of course, are alternately in opposite directions, and to correct this, a "communicator" is placed on the moving shaft, which, by reversing the connections at the right moment, sends the currents always in the same direction through the exterior wire.

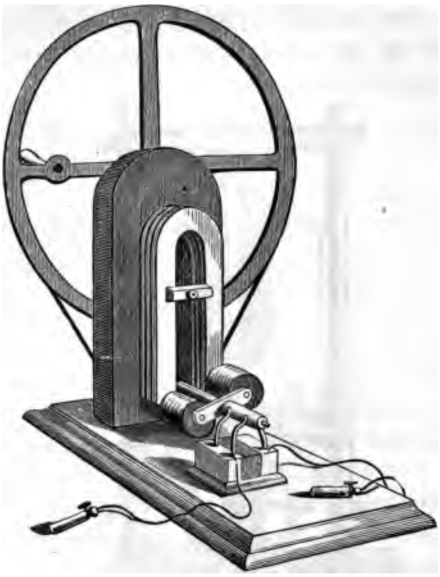


FIG. 17.

Saxton, in Philadelphia, made in 1833, a modified form in which the steel magnets were placed horizontally, and remained at rest while the coils with their soft iron cores, were rotated

opposite their ends. Various small modifications followed. Thus, in 1836, Clarke, in London, made a machine represented in Fig. 17, in which the steel magnet was made of several single magnets united, and the coils were rotated opposite the poles, but at right angles with the plane of the magnets.

Again, Breton wound coils on the poles of the magnet, and then rotated an armature in front. This armature, by its approach and withdrawal, caused movements in the lines of force, or in the magnetic currents, which developed momentary currents of electricity in the coils of wire. The relation of this action to Breguet's apparatus, for exploding mines, and to the Bell telephone, is worthy of notice.

Duchenne combined this last plan with the preceding one, by winding coils both on the magnet and the armature, and using one or other of the circuits for his induced current.

The first attempt to make a magneto-electric machine of such a size as to be available for industrial purposes, was made in 1849, by M. Nollet, Professor of Physics at the Military School at Brussels.

The original intention of those first engaged in developing this machine was not, however, to produce with it an electric light, but to employ it to *decompose water in order that the hydrogen so liberated might be used as an agent of illumination.* If we were in want of an illustration of the extravagance and irrationality of expectation which so often exhibits itself in enterprises entering upon new fields, we surely need go no further than this. M. Nollet died before his designs were entirely carried out; but they were elaborated by an intelligent workman who had assisted him in the construction of his machines, M. Joseph Van Malderen, who, under the auspices of a company composed of French and English capitalists, and named the "Alliance Company," developed the apparatus into an efficient generator of electric currents for the direct production of light by means of the electric arc.

The apparatus, as thus constructed, was, in general principle, only an enlargement of the Clarke machine (already shown), and consisted of a large number of compound steel magnets, between the adjacent sides of which cores of soft iron, sur-

rounded with coils of insulated wires, were made to revolve. An appropriate connection of these various coils with each other, and with commutors on the axis, enables the current to be taken off in a constant direction. When it was afterwards discovered that, for an electric light, the current need not be constant in direction, but was even more convenient when rapidly alternating, this was of course yet more easily provided for. Fig. 18 shows one of these Alliance machines, which

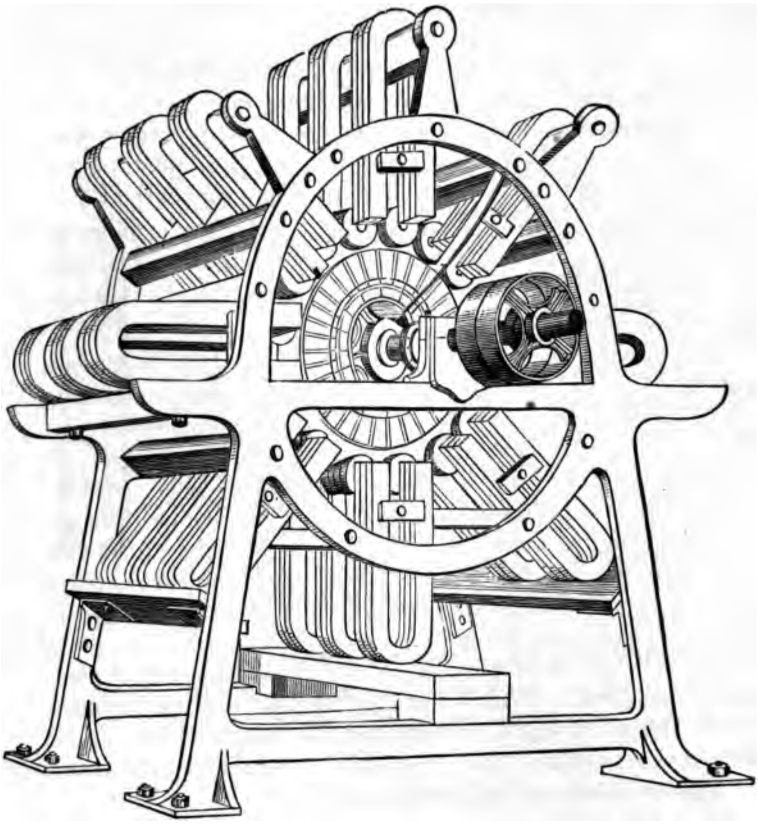


FIG 18.

really needs no further description, but is rendered perfectly clear in its structure and operation by the cut.

Many of these "Alliance machines" were made and used in different places in France for lighting works of construction at night, such as the Cherbourg docks, and on some vessels, as the Lafayette and the Jerome Napoleon, and in some lighthouses; and, as modified slightly in arrangement of parts by Mr. Holmes, in England, notably in the South Foreland lighthouse.

The great cost of these machines, the large amount of power required to run them, and the cost and trouble of keeping them in repair, however, limited their use to a very narrow field, and they could hardly be said to have carried the subject of electric lighting beyond the range of an interesting scientific experiment on a large scale.

The next important step in the development of the magneto-electric machine consists in the application by Dr. Siemens of his peculiar armature to these instruments.

This armature is shown in longitudinal section in Fig. 19, at E, and in cross section at F.

The armature is, in fact, a rod or bar of soft iron, with deep grooves cut lengthwise along it, reducing its section to an H form, as is shown in F. Insulated wire is then wound lengthwise in these grooves, as shown in E. Such an armature as this, mounted with caps, as shown in Fig. 19, may then be rotated in a very narrow and dense magnetic field, and its wires will cut many lines of magnetic force in a short time, by reason of their rapidity of angular movement, being close to the axis of rotation.

This armature was first used in magneto-electric machines employed for telegraphing by Siemens, in 1857.

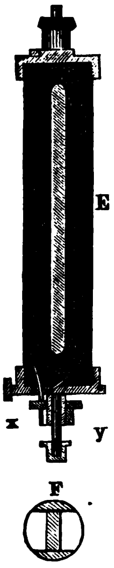


FIG. 19.

The next advance, and this a very marked one, was made in 1866, by H. Wilde, of Manchester, who, on April 13, communicated to the Royal Society the result of a series of experiments with magneto-electric machines, of which Fig. 20 is a good representative.

In this machine, a number of small horse-shoe magnets are so arranged that a Siemens' armature may be rotated between their poles.

The coils on this armature have developed in them, by moving in this highly concentrated, magnetic field, a very powerful current. This current is then passed through heavy coils of wire surrounding the sides of a large U magnet, made of massive plates of wrought iron. Between the poles of this, rotates another Siemens' armature of larger size, from which, a current of immense power is obtained.

While the electric current developed by this machine, far exceeded anything which had ever been obtained before, it was only secured by a large expenditure of power—something between a five and a twenty-horse power engine being required to drive it.

The important fact developed by Mr. Wilde in this machine, was, that a magneto-electric machine could develop a current whose magnetizing power was vastly greater than that of the

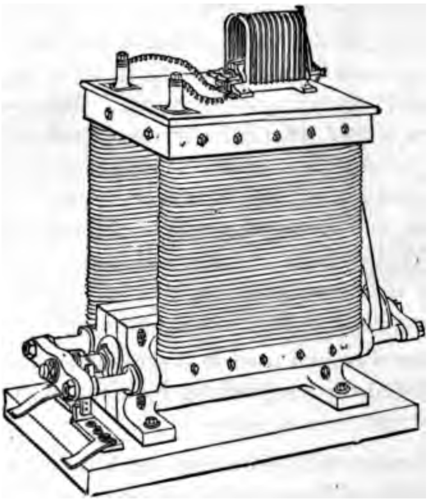


FIG. 20.

magnets from which it was derived. Thus, if the small magnets above would lift a weight of 50 pounds, the large electro-

magnet below, when excited through their instrumentality, would lift 500 pounds or more. This possibility of a sort of magnetic accumulation or growth, was a demonstration of immense value to the progress of magneto-electric science.

A practical difficulty which first showed itself in a conspicuous degree in these very powerful machines, was the heating of the armature. Foucault had first shown, long before, that when a conductor was rotated or moved in a magnetic field, it became strongly heated.

His apparatus to illustrate this, is shown in Fig. 21, where a copper disc is rotated between the poles of a powerful magnet, and becomes very hot.

Fig. 21.

Tyndall, by similarly rotating a copper tube, melted the fusible metal with which it had been filled.

The heat developed in the armatures of Wilde's large machines was so great as to cause serious inconvenience, and of course involved a great loss of effect, or waste of power.

In 1867 Siemens proposed a very obvious modification of

this machine of Wilde, by dispensing with the smaller machine and connecting the coils of the large one with its own armature through the commutator of the same. The residual magnetism of the iron of the electro-magnet was found sufficient to start the action, which then increased by self-development.

This, however, occasioned what was at first regarded as a serious difficulty.

If the magnetism of the electro-magnet was thus made to depend on the current of the machine itself, any interruption in the flow of the same in the exterior circuit, at once cut down or destroyed this magnetism, and so reduced the whole action.

To obviate this, Ladd, of London, first made a machine with an armature wound with two coils of wire, one being connected with the magnet of the machine, and the other with the exterior circuit.

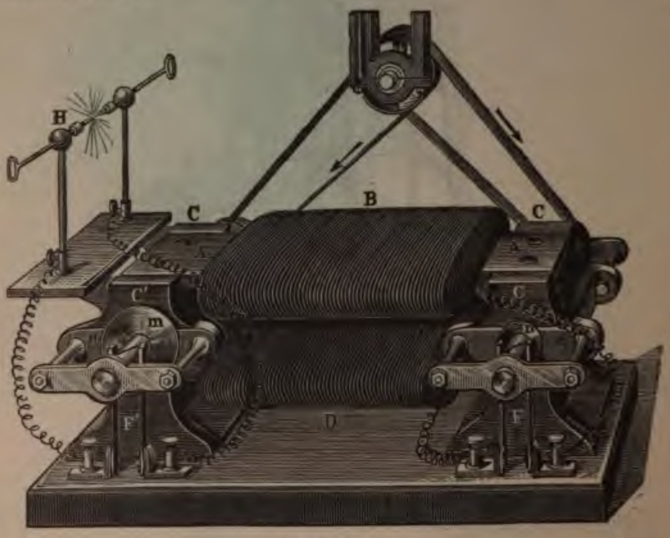


FIG. 22.

Afterward he made a machine in the form shown in Fig. 22, where two armatures were used—one connected with the coils of the machine itself, and thus supplying what is often called the "field of force," the other supplying the exterior circuit.

Subsequent experiment has, however, shown that the arrangement is very far from economical in the conversion of energy, and all the machines now in use include the exterior circuit and the field of force in one continuous connection.

This, of course, greatly complicates the relations, and makes the fluctuations during running greater and more numerous; but for the sake of efficiency, or the economy of expended power, it has been found essential to adopt this arrangement.

PACINOTTI'S RING MACHINE.

The first magneto-electric machine for the production of an electric current continuous in character and constant in direction and intensity, was that devised by Dr. Antonio Pacinotti, in 1860, and constructed by him for the physical and technological cabinet of the University of Pisa. A description of it, however, did not appear till several years later in the June, 1864, number of the Italian scientific periodical, "*Il Nuovo Cimento.*" This number, which was published during the month of March, 1865, contained an extended illustrated description of the machine.

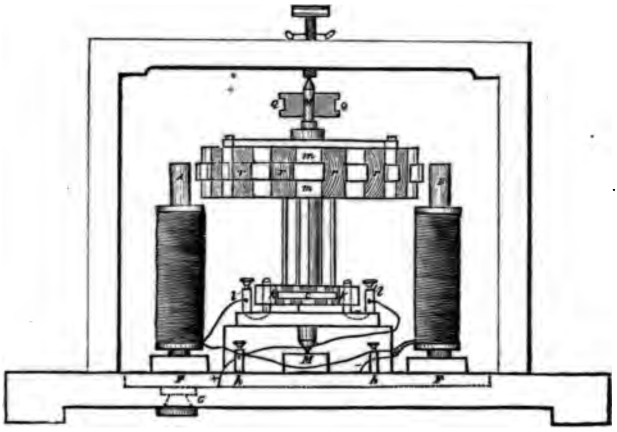


FIG. 23.

As a special feature of the apparatus he pointed out the peculiar form of the movable electro-magnet—a circular iron ring in which, contrary to the case with the armatures pre-

viously in use, the magnetic poles did not remain stationary, but could be moved within the ring—that is, made to assume in it successively all possible different positions.

This movable ring of iron had the shape of a spur wheel of 16 teeth, and was firmly secured to the axis of the machine by means of four strips of brass. Small wooden wedges were placed upon the teeth of the ring, and the space so formed between each two of the wedges filled up regularly with insulated copper wire. These spools were all wound in the same direction, and the terminal end of each was soldered to the beginning of the one succeeding it, so that the whole system of 16 spools virtually formed a single coil of wire surrounding the ring in a regular manner, and returning upon itself.

Wires were soldered to the separate points of juncture and were led, parallel to the axis of rotation, to an equal number of insulated pieces of brass, mounted in two rows upon, and slightly projecting from, the surface of a disc firmly secured to the axis.

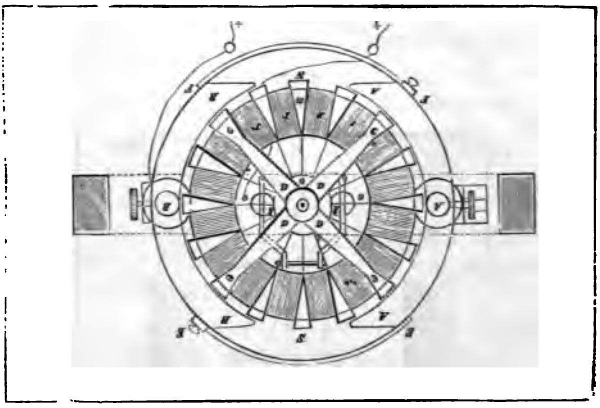


FIG. 24.

The iron ring, with the bobbins wound upon it in the manner already described, was mounted in a horizontal position between the two legs of a powerful upright electro-magnet, the distance of which from the ring could be adjusted at pleasure by means of a set screw and a slot in the lower connecting cross-piece. Contact rollers, *k k*, were made to

press, one on each side of the axis, against the lower wooden disc carrying the strips of brass, so that during the rotation of the ring all of the latter were brought successively into contact with them. When, therefore, the terminal posts, *h*, *h'*, are placed in connection with the poles of a galvanic battery, the current will pass, supposing it to enter at *h* (+), by way of the binding post, *l*, to the roller *k*, and through the strip of brass on the disc against which the roller may happen to press at the time, up to the two wire coils of the armature whose point of juncture is in connection with this strip of brass.

The current here divides, each portion passing in an opposite direction through the spools surrounding each half circumference of the ring, to meet again to form one current at the left contact roller, *k*, from where the reunited current passes to the second binding post, *l'*. From here the current proceeds to the leg A of the electro-magnet, circulates around it, and, after acting similarly with regard to the other leg B, passes back by way of the binding post *h'* to the negative pole of the battery. Magnetic poles thus became developed in the iron ring at the points N S, the position of the contact rollers having been so chosen as to bring about this effect, and the actions of attraction and repulsion taking place between them and the poles of the stationary electro-magnet gave rise to the rotation of the ring.

In order to turn the action of the electro-magnet upon the magnetized iron ring to the greatest possible account, Pacinotti provided the two poles with armatures, AAA, BBB, of soft iron, which were made to surround the ring very closely for over two-thirds of its circumference. Strips of brass, EE, FF, attached, served to give them greater security. In the elevation of the machine here given these armatures have been omitted in order not to conceal the ring and its surrounding spools.

The foregoing description of the ring of Pacinotti and its action has more especial reference to its application in an electro-magnetic machine, but toward the end of his article Pacinotti clearly indicates in what way, by the use of the same annular armature, the electro-magnetic may be converted into a

magneto-electric machine, capable of producing, by the proper use in connection with it of a permanent or electro-magnet, a continuous current of a constant direction.

On substituting for the electro-magnet AB a permanent magnet, and on rotating the ring armature, the poles induced in the ring by the proximity of the magnet will always be found at the extremities of the diameter passing, when produced, through the poles of this exterior magnet; so that we may come to consider the spools as alone partaking of the rotary motion, while the two semi-circular magnets produced by the induction remain at rest. The current induced in any particular spool will, in the motion of the latter from N to S, preserve the direction it has on leaving N until it reaches *a*, a point midway between N and S. Here a reversal in direction of the current takes place, which new direction is preserved until the spool arrives at *b*, a point midway between S and N, where a reversal to its former direction of the current occurs, and so the action continues. The currents developed in the different spools will therefore add to each other's effect, and are hence most properly collected at the points A and B, the collecting brushes coming thus to act upon the commutator at right angles to the magnetic axis of the rotating armature.

FIG. 25.

Pacinotti did actually obtain an uninterrupted current of constant direction on causing the opposite poles of permanent magnets to approach the ring during the rotation of the latter.

He also obtained the same effect by magnetizing the stationary electro-magnet by means of a current, though he deemed the former method preferable.

The claim of Pacinotti to priority in the invention and application in magneto-electric machines of the annular armature has already been fully established, and is daily becoming more generally recognized.

SIEMENS-HALSKE MACHINE.

The following description is translated from the admirable treatise entitled "Die Magnet und Dynamo-elektrischen Maschinen," by Dr. H. Schellen, just published:

"We have already drawn attention to the fact that when metallic bodies are caused to move in a magnetic field, such motion developes in them induced, or so-called Foucault currents, which, if not conducted away, become transformed into heat, and thus, according to the circumstances of the case, give rise to a considerable heating of the metallic bodies in motion. As long, therefore, as the iron core revolves with the coiled drum through the magnetic field of the exterior magnets in the magneto-electric machine just described, these currents are not to be avoided, though they may be dimished to some extent by constructing the armature of coils of iron wire instead of massive iron. In such machines, however, which are built for the purpose of producing very large quantities of electricity, and which for this reason are constructed in accordance with the dynamo-electric principle, these Foucault currents would be attended by a considerable increase in the temperature of the machine, in addition to which considerable power would be required in order to rotate the iron armature, owing to its becoming so strongly polarized by the powerful electro-magnets developed, for which power there would be no equivalent return in useful effect.

"These considerations must have determined the inventor to secure the iron armature inside the drum, and so prevent it from taking part in the motion of the latter in such dynamo-electric machines, like those to be used for illuminating purposes, for instance, as are intended for the productlon of large

quantities of electricity. As a matter of course, this renders the construction and mode of arrangement of the drum much more complicated, and all the more so when it is considered that the long drum, with its surrounding coils of wire, has to be moved through the narrowest possible space between the pole armatures of the electro-magnets and the stationary inner core.

" Fig 25 and 26 represents the construction, in detail, of such a dynamo-electric machine on the v. Hefner-Alteneck system. A horizontal section of the drum and a side view of the complete machine are there given. *abcd*, is a thin German silver drum upon which, in the manner already described, the

FIG. 26.

wire is wound in many circumvolutions, and in eight separate coils. Each terminal face carries a short tube, which tubes form the trunnions of the drum, and which lie in boxes, F_1 and F_2, provided with oil cups. An iron shaft, CC, secured by means of screws in the pillars, D_1 and D_2, passes through these tubes into the interior of the drum, where the core, nn_1, ss_1, held together by two discs bolted to each other, is fastened upon it. The drum is surrounded on the outside at two opposite places for about two-thirds of its circumference, and over its entire length, by two curved iron armatures, NN_1 and SS_1. These are placed as closely as possible to the wire drum, and form, with the stationary hollow interior core, nn_1, ss_1, a narrow annular space, the magnetic field, through which the drum *abcd*, with its surrounding wires, must be able to pass in its rotation with all possible freedom.

"Inside of the front hollow trunnion of the drum which rests in F, there passes another hollow tube, which is secured to the end face of the drum, and between which and the trunnion the ends *ee*, of the separate wire coils, are led through to the commutator, pp_1, attached to its front end.

"The two curved iron armatures NN, and SS, terminate in flat plates, No S*m*, and N_1o_1, S_1m_1, which constitutes the cores of the electro-magnets, EE, E_1E_1, and through which the armatures are rendered magnetic. These cores are united at their ends by strong soft iron connecting pieces, om and o_1m_1, which also serve the other purpose of forming the side portions of the cast iron framework of the machine. Here also the wires of the two horse-shoe-shaped electro-magnets, E and E_1 are wound in such way that the poles of the same name are opposite each other, so that all portions of the iron arch uniting each set of these poles exhibit the same kind of polarity. In this way the drum and the interior iron core are surrounded for about two-thirds of their circumference, and over their entire length, by the stationary exterior magnetic poles, NN_1 and SS_1 and a very extended magnetic field formed by this means, the intensity of which will be the greater the more powerful the induced currents developed, and, in consequence, the poles of the electro-magnets become.

"In order to carry out the dynamo-electric principle, the coils of the two electro-magnets, EE, and E_1E_1 are connected with the commutator brushes, or the contact rollers, in such a way that the current generated by the machine traverses successively the wire surrounding the drum, the coils of the electro-magnets, and the electric lamps placed in the circuit. The two systems, the induced currents of the drum and the poles of the electro-magnets, exert, up to a certain maximum limit, a mutual strengthening action upon each other, which limit is determined by the wires upon the drum, the velocity of rotation of the latter, and the mass of iron in the cores of the electro-magnets.

"In order to drive so powerful a machine, a steam engine, or other uniform source of power will be required. As long as the circuit remains unclosed, and the two binding screws are

not in metallic connection with each other, the rotation of the drum may be effected by the expenditure of sufficient force to overcome merely the friction in the journal boxes, F_1 F_2. If, however, the external circuit is closed, by the introduction of an electric lamp, for instance, the induced currents will at once be developed in the drum, if but a trace of magnetism exist in the armatures, NN_1 and SS_1. These currents, by adding to the strength of the electro-magnets, exert a strengthening action upon the armatures, and thereby become themselves strengthened. The quantity of electricity generated by the machine, as well as the mechanical power expended in running it, will thus rapidly become greater, since every increase in magnetism is attended by a corresponding increase in the intensity of the current. It is for this reason that, for certain purposes, for producing a *steady* electric light, for instance, a uniform action of the driving engine is absolutely necessary; and all the motors designed to be used in the driving dynamo-electric machines must, on this account, be provided with reliable regulating contrivances, in order to secure such uniformity as much as possible.

"In using the machine for the production of the electric light, it may happen that, through any external cause, impurities in the carbons, for instance, the arc becomes extinguished and the current interrupted. In such a case the consumption of power on the part of the machine suddenly falls almost to zero, and a considerable (even dangerous) increase in the velocity of rotation of the drum would be the consequence thereof, were the driving engine to continue working at the same rate without having a corresponding resistance to encounter. In order to meet any such danger Siemens and Halske have provided their machine with an automatic switch, which throws into the circuit an artificial resistance when, through any cause whatever, the circuit is interrupted in the lamps.

* * * * * * *

"The machine represented in Figs. 25 and 26, has a length of about 10½ centimetres, a height of 32, and width of 46½ centimetres, and yields, when the drum revolves at the rate of 450 per minute, for which six horse power are required, an

electric light of 1,400 standard candles. The current produced by it is capable of heating to redness a copper wire one metre long and one millimetre in thickness.

"In the machines of medium and smallest size, in order to secure the necessary simplification in construction, the iron cylinder is firmly united with the wire coils, and rotates with them. The fixing of this inner armature, on the contrary, is rendered necessary in such cases in which there occurs a very frequent change of polarity, and in which the utmost utilization of the driving power is called for, which is usually only the case with the larger machines.

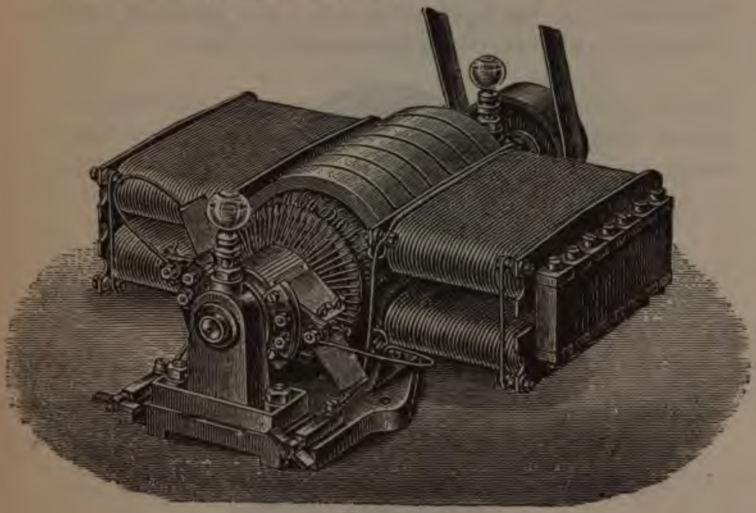


FIG. 27.

"Fig. 27 represents in perspective a Siemens-Halske machine (system of v. Hefner Alterneck), of the latest construction. The electro-magnets have the flat shape of those used in Wilde's machine. The current is taken off by means of metallic brushes, and the large number of radical pieces in the commutator shows that the drum carries a larger number of separate coils.

"In the latest machine of this form the commutator disc is done away with, and the ends of the separate wire coils surrounding the drum are connected with each other and led to

the radical pieces of the drum shaft in a somewhat similar manner to that obtaining in the Gramme machine, which has already been described. These radical pieces are insulated from each other by means of asbestos paper. Contact rollers are no longer employed, their place being taken by flat elastic bands (brushes), made of silver-plated copper wires.

"The smaller size of these machines is 698 mm. in length· 572 mm. wide, and 233 mm. high ; the drum alone is 388 mm, long, and carries 28 wire coils and a commutator divided into 56 parts. Its weight amounts to 115 kilogrammes; the maximum velocity of the drum, 900 revolutions per minute ; and the intensity of the light produced, 1,400 standard candles. One and a half horse power are required to run it.

FIG. 28.

The medium size differs, in construction, but slightly from the one just described. It is 757 mm. in length, 700 mm. wide, and 284 mm. high ; the drum has a length of 456 mm., and is also wound with 28 coils ; the commutator is, therefore, also composed of 56 pieces against which wire brushes are made to press. The machine weighs 500 kilogrammes, and produces,

with its maximum velocity of 700 revolutions per minute, a light of 4,000 candles. It requires 3½ horse power.

In 1871, M. Z. T. Gramme, a cabinet maker of Paris, presented to the French Academy the description of a new form of magneto-electric machine, possessing several new and remarkable features. Its general structure can be well understood from the accompanying figure, which represents one of its simplest forms as constructed with permanent magnets, and to be driven simply by hand power.

The large U. magnets terminate in heavy end pieces, which constitute massive north and south poles, almost surrounding the armature, which constitutes the peculiar feature of this machine.

This armature consists of a ring made of a coil or hank of soft iron wire, around which are wound a series of coils of copper wire, in the manner shown in Fig. 29, which represents such an armature partially dissected.

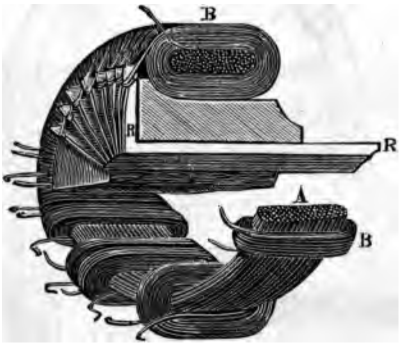


Fig. 29.

The ring made of a hank of iron wire is shown cut across and spread out to some extent, the cut ends appearing below B and at A. The several coils of wire are also represented partly in place above and spread apart in the lower part of the figure. The wire of these coils passes continuously from one to another, but between each makes a loop, which is hooked into a copper conductor, RR, constituting part of the commutator.

The general principle on which this maching acts can best be explained by reference to the diagram (Fig. 30). Let S and N represent the poles of the permanent magnet, and the divided ring between them stand for the ring of iron wire.

This ring, under the influence of the poles S and N, will always have a north pole at *n* and a south pole at *s*, the parts *p* and *p*, being neutral, or, in other words, will correspond with two semi-annular magnets with their north poles together at *n* and their south poles together at *s*. The magnetic currents in the various parts of this ring will then be represented by the arrows drawn on it. As the ring rotates these poles will always maintain essentially the same position in space, and therefore, in relation to the coils wound on this ring, we might assume that this inner ring was at rest, and that the coils above were carried round over it.

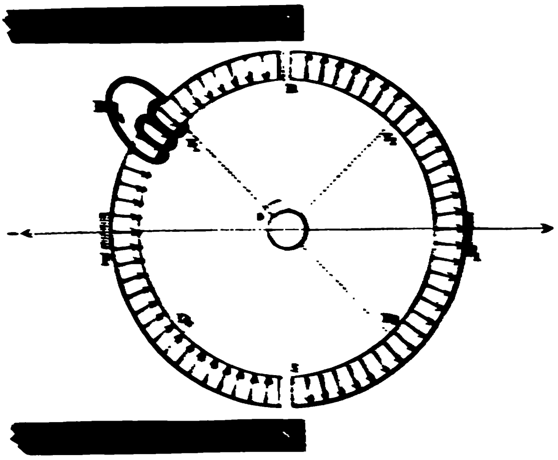


FIG. 30.

Now let R indicate such a coil, and suppose it to move toward the right; it will evidently leave more magnetic currents in a given direction in the left hand semi-annulus, than it approaches, and will, therefore, acquire a current in the direction shown by the arrow, to which will be added the effect due to approaching the opposite currents in the upper part of the right hand semi-annulus. At *n*, and also at *s*, this action will

reach a maximum, as the coil will be (at n, for example) approaching all currents of the right hand semi-annulus, and leaving all those of the left, and vice versa at s. At p and at p_1, however, the effect will be nil, as the coil would there approach and leave equal numbers of currents of like direction.

Now if we consider a number of coils all moving around from left to right, on the upper part of the ring, the currents in them will have the same direction; and if they are all connected together, these currents will aid each other, and may be taken off by conductors pressing on the commutators at p and p_1. Let us suppose that the current is such as to make p_1 positive and p negative. As the coils pass p_1 the direction of the currents in them is reversed, but so also in their relation to the conductor or commutator. Thus, a coil which was coming toward p_1 from above, was sending its positive current forward toward p_1; as it leaves p_1, going onward below, its current being reversed, it no longer sends its positive current forward, but sends it back to p_1, which it has passed. Thus, p_1 gets not only the positive current from the coils on the upper half of the ring, but from those also on the lower half.

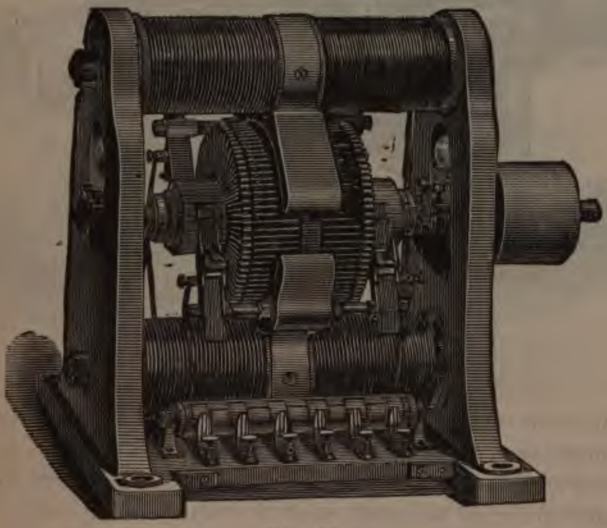


FIG. 31.

By reason of the action which has thus been described, there is, in the first place, no rapid reversal of magnetism in the iron core of the armature, as in the Wilde machine, but only a continuous and progressive change, as the ring rotates; and in the second place, there is a continuous current of electricity in a constant direction, with only one reversal for each revolution of the entire set of coils.

Of course the method of passing the current of one machine through the coils of an electro-magnet, replacing the permanent magnets shown in Fig. 28, could be carried out with this machine, just as with Wilde's; or the machine itself, being made with electro-magnets, these could be excited by its own current, as with the machines of Ladd, and of Siemens, which we have already described. This last plan was, in fact, at once adopted and the standard Gramme machine was made in the form shown in Fig. 31.

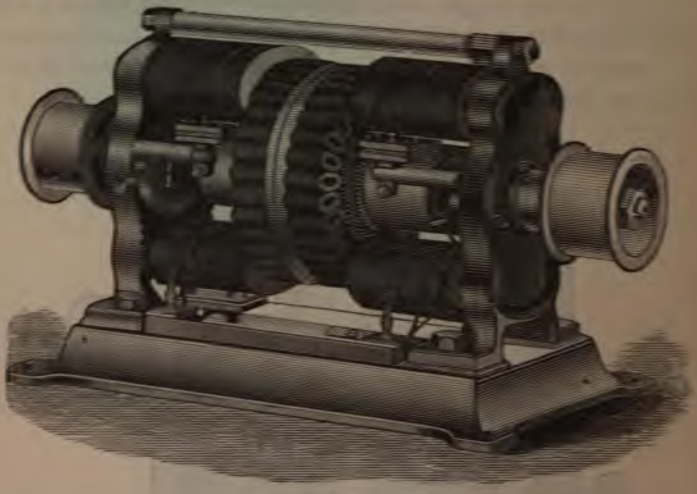


FIG. 32.

Here the electro magnets consist of the large horizontal cylinders seen above and below, so wound with wire as to produce a combined north pole at the centre above, where the extension piece is attached, and a corresponding south pole below.

Within and between these extension pieces is the armature, or bobbin, consisting of the iron ring wound with its numerous flat coils. The connections in this case are carried out on both sides of the axis, and thus several pairs of brushes can be applied, and numerous currents taken off.

With all these machines, however, the best effects are obtained by employing only one circuit, or passing the whole current from the bobbin through the electro-magnet coils and the exterior circuit, where it is used.

In 1873 Wilde described a new form of magneto-electric machine, in which he abandoned the use of the Siemens armature, and returned, in general structure, very much to the form of the old Alliance machine.

Two sets of electro-magnets, 16 in each, were arranged in such a way that they formed two hollow cylinders opposite each other, with the poles of the magnets of each cylinder facing each other, but having space between for another cylinder of 16 electro-magnets, mounted parallel with the others, and carried by a disc of iron, from which they projected at each side. In fact, there were three cylinders of magnets, all having a common horizontal axis; the outer ones fixed and the inner ones radiating, so as to carry its magnets between the poles of the others.

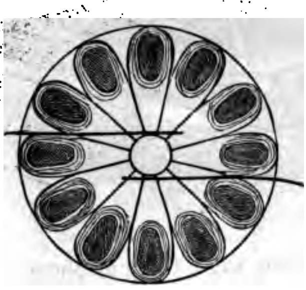


FIG. 33.

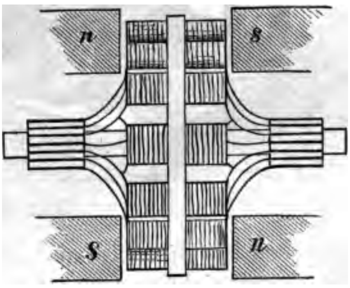


FIG. 34.

Good effects were obtained with this machine, and the heating of the armatures was avoided, but it was not found to equal the improved Siemens or the Gramme in efficiency or economy of power.

In 1875 a patent was taken out in the United States by Mr. Moses G. Farmer for a machine essentially like that of Wilde, just described. This, with some modifications of details, is now manufactured by Wallace & Sons, of Ansonia, and has come into very general use.

In the experiments made by the present writer, as well as those conducted by the Franklin Institute, this machine seems to be inferior in "duty" to some others; but the conditions of such trials are so difficult to establish, in adapting the nature of the exterior circuit including the lamp, to the peculiarities of each machine, that I should not regard these conclusions as absolutely final.

In the Wallace-Farmer machine (Fig. 32) the magnetic field is produced by two horse-shoe electro-magnets, but with poles of opposite character facing each other. Between the arms of the magnets, and passing through the uprights supporting them, is the shaft, carrying at its centre the rotating armature.

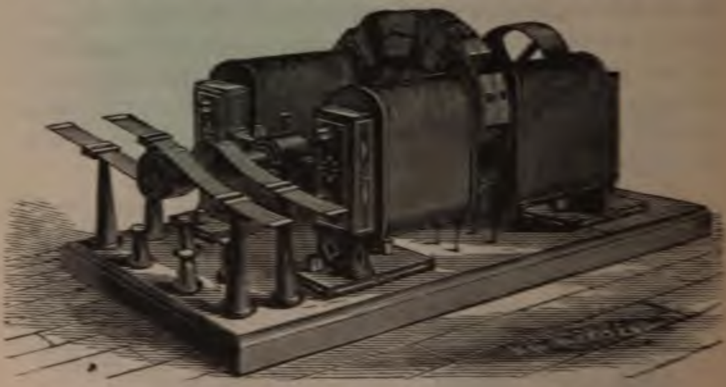


FIG. 35.

This consists of a disc of cast iron, near the periphery of which, and at right angles to either face, are iron cores, wound with insulated wire, thus constituting a double series of coils. These armature coils (Figs. 33 and 34) being connected end to end, the loops so formed are connected in the same manner, and to a commutator of the same construction as that of the Gramme. As the armature rotates, the cores pass between the

opposed north and south poles of the field magnets, and the current generated depends on the change of polarity of the cores. It will be seen that this constitutes a double machine, each series of coils, with its commutator, being capable of use quite independently of the other; but in practice, the electrical connections are so made that the currents generated in the two series of armature coils pass through the field-magnet coils, and are joined in one external circuit. This form of armature also presents considerable uncovered surface of iron to the cooling effect of the air, but its external form, in its fan-like action on the air, like that of the Brush, presents considerable resistance to rotation. In the Wallace-Farmer machine there was considerable heating of the armature, the temperature being sufficiently high to melt sealing-wax.

Another machine made and used in this country to a considerable extent is that of Mr. Brush, manufactured by the Telegraph Supply Co., Cleveland, O. This is shown in Fig. 35.

The Brush machine has for its magnetic field two horseshoe electro-magnets, with their like poles facing each other, at a suitable distance apart, the circular armature rotating between them.

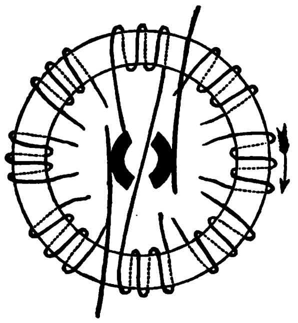


FIG. 36.

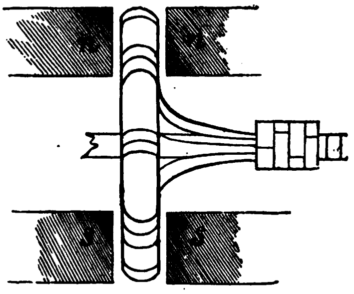


FIG. 37.

In this machine the currents are generated in coils of copper wire wound upon an iron ring, constituting the armature. This ring is not entirely covered by the coils, as in the Gramme armature, but the alternate uncovered spaces between the coils is almost completely filled by iron extensions from the

ring, thus exposing large surfaces of the armature ring for the dissipation of heat, due to its constantly changing magnetism, as in the Pacinotti machine.

The ring revolves between the poles of two large field magnets, the two positive poles of which are the same extremity of the diameter of the armature, and the two negative poles at the opposite extremity, each pair constituting practically extended poles of opposite character.

The coils on the armature ring are eight in number, opposite ones being connected end to end, and the terminals carried out to the commutator. Figs. 36 and 37 show this arrangement, only one pair of coils, however, being shown in Fig. 36 as connected. In order to place the commutator in a convenient position, the terminal wires are carried through the centre of the shaft to a point outside the bearings.

The commutators are so arranged that at any instant three pairs of coils are interposed in the circuit of the machine, working as it were, in multiple arc, the remaining pair being cut out at the neutral point; while in the Gramme machine, the numerous armature coils being connected end to end throughout, and connections being made to the metal strips composing the commutator, two sets of coils in multiple arc are at one time interposed in the circuit, each set constituting one-half of the coils on the armature.

The commutator consists of segments of brass, secured to a ring of non-conducting material, carried on the shaft. These segments are divided into two thicknesses, the inner being permanently secured to the non-conducting material, and the outer ones, which take all the wear, are fastened to the inner in such a manner that they can be easily removed when required.

The commutator brushes, which are composed of strips of hard brass, joined together at their outer ends, are inexpensive and easily renewed. The high speed at which these machines are run, together with the form of the armature, cause the rotation of the latter to be considerably resisted by the air, and producing a humming sound, but otherwise they run smoothly, the heating of the armature being inconsiderable—not exceeding 120° Fahr., after four and three-quarter hours run.

When the Jablochkoff candle came into vogue, it became highly important to go back in one of the directions in which improvement had been made in most of the recent machines, and produce a machine which should yield alternating or reversing currents, in place of those passing continuously in one direction. This was necessary to equalize the consumption of the two parallel carbons of the Jablochkoff, and also, even with other lamps, for purposes which we will explain further on.

To meet this requirement, Gramme has arranged a machine which not only produces alternating currents, but operates readily, at the same time, a number of separate circuits. It is these machines which were recently used during the Exposition

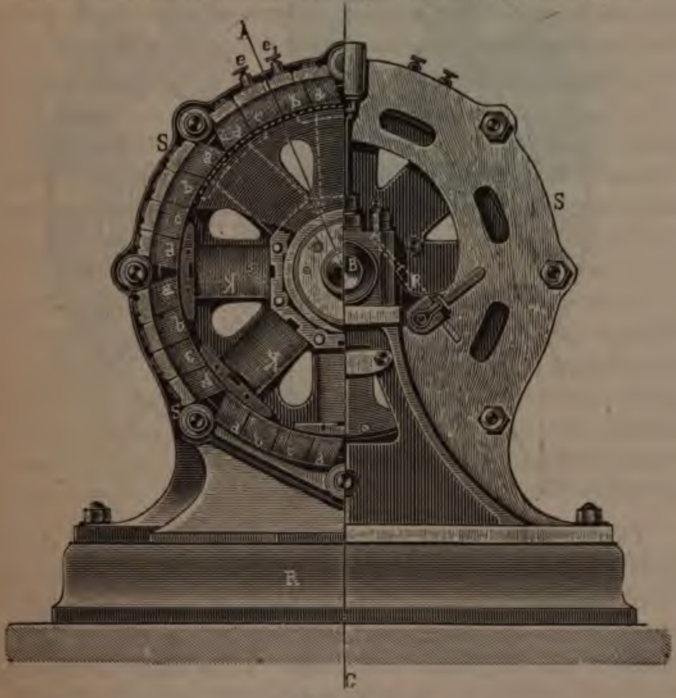


Fig. 38.

to light certain streets and public places in Paris. The general appearance of this machine is shown in Fig. 38.

This machine, it will be observed, differs radically from the continuous current machine of Gramme.

In the first place, it is, as it were, turned inside out. Thus, there is a magnetic ring wound with successive coils, but this, in place of revolving within the field of fixed electro-magnets, is stationary on the outside, while a series of eight electro-magnets, excited by a separate machine, rotate in the interior of this fixed armature ring.

The principle of the machine will be readily understood from the diagram (Fig. 39).

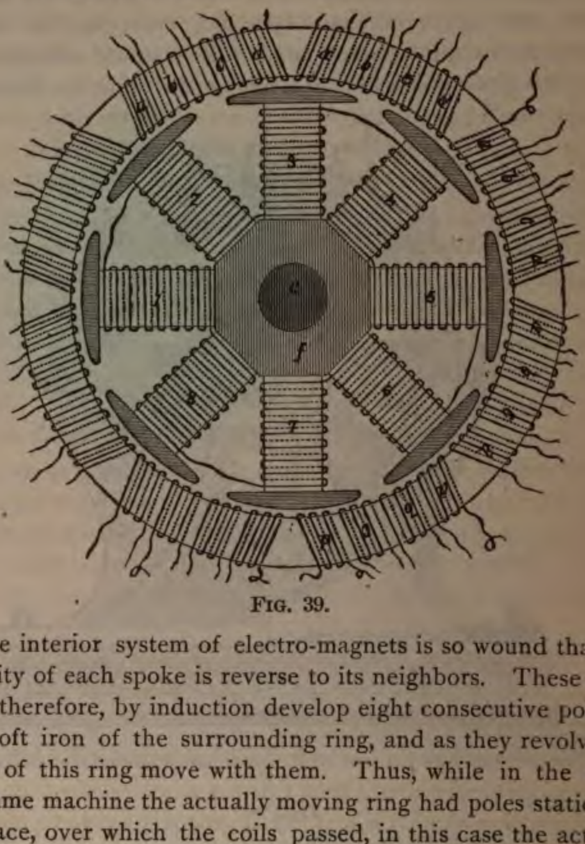


FIG. 39.

The interior system of electro-magnets is so wound that the polarity of each spoke is reverse to its neighbors. These magnets, therefore, by induction develop eight consecutive poles in the soft iron of the surrounding ring, and as they revolve the poles of this ring move with them. Thus, while in the older Gramme machine the actually moving ring had poles stationary in space, over which the coils passed, in this case the actually stationary ring has moving poles which pass through the stationary coils.

These coils are wound in eight sets, each alternate set being wound in an opposite direction, and each set is made up of several separate coils, to facilitate the making of all sorts of combinations, which are most easily arranged in this machine, as no commutators are used, and all the coils are fixed.

If all the coils marked *a* are connected together, it is evident that at any moment the currents in all of them will be in the same direction. Thus, suppose the electro-magnet spoke 2 to have a north pole at its outer end, and 3 to have a south pole similarly situated ; then as 2 moves over *a* it will produce a current alike in direction to that produced by the opposite pole of 3 moving over the oppositely wound wire of the next coil, marked *a*.

Of course, as the magnet 2 leaves *a* and the oppositely polarized magnet 1 approaches, this current will be reversed in the first coil marked *a*, and also, likewise, in the second coil *a*, for a like reason.

It has been stated that these machines worked one Jablochkoff candle for each horse power consumed, but several who watched their actual running say that very much more power was actually consumed.

THE LONTIN MACHINES.

Among the machines for generating electricity that have commanded more or less of general attention, may be included the magneto and dynamo-electric machines devised by Lontin. In their mode of construction and arrangement these machines possess features which recall the Alliance and Holmes magneto machines on the one hand, and the Siemens and Gramme dynamo machines on the other.

There are two styles of Lontin dynamo machines, the one yielding continuous currents of one direction, and the other producing alternating currents.

In the machine of the first form, a number of bar electro-magnets are disposed radially about a central shaft of soft iron, and the star-shaped wheel thus formed is made to revolve between the poles of an ordinary powerful U-shaped electro-magnet. The wire of the electro-magnet wheel forms one com-

plete circuit, and is connected at the several points of juncture of each two successive magnet coils, with the appropriate section of a commutator, placed upon the axis of the machine. On revolving the wheel between the poles of the stationary upright field magnet, it will readily be seen that, considering any individual radial electro-magnet, there will be induced in the coil of the latter, during its motion away from one pole and its consequent approach to the opposits pole, a current which, though varying (first diminishing and then increasing) in intensity, will still maintain a constant direction until the coil has arrived at the opposite pole, where a reversal of the current will take place. The current will continue flowing in this new direction until the revolution of the wheel brings the coil back to the pole from which we have considered it to start, when and where the current will be restored to its former direction. At any moment, therefore, during the revolution of the wheel, all the electro-magnet coils in the upper half of the wheel will be traversed by a current flowing in one direction, and all those in the lower half by one in the opposite direction. Elastic strips, one on each side, bear against the commutator in the line where the reversal takes place, and lead away the currents to the proper binding posts. The mode of generation and direction of the currents in this form of the Lontin machine is thus seen to be exactly similar to that obtaining in the Gramme machine.

The stationary electro-magnets are included in the main circuit, in accordance with the dynamo-electric principle. By mounting several of these wheels of electro-magnets, with separate commutators and field magnets, on the same central shaft, an equal number of independent currents may be obtained, which, by appropriate means may, of course, be combined in any desired manner.

By winding the alternate electro-magnets on each wheel in opposite directions, the machine may be made to produce currents constantly varying in direction. The Lontin machine proper, for alternating currents, has, however, a more elaborate form, bearing a rather close resemblance to the machine devised by Holmes.

This Lontin machine consists essentially of an electro-magnet wheel, like that in the first described form of the machine, only that the magnets are much more numerous, amounting in number to 24, and over, and are wound in the manner just referred to—that is, the alternate magnets are wound in opposite directions; and of a large stationary soft iron ring surrounding this wheel concentrically, to which ring there are secured, at equal distances apart, a number of short electro-magnets, equal in point of number to the electro-magnets of the inner wheel. The electro-magnet coils of the revolving wheel are connected together, so as to form one circuit. The current necessary for the saturation of these magnets is obtained from an auxiliary machine (a Lontin machine of the first form, for instance), mounted upon the same axis, connections being so made, by means of brushes and collars, that the rotation of the large wheel does not interfere with the circulation of this current. The ends of the electro-magnets, during the rotation, pass very closely by the cores of the outer stationary magnets, and as the successive magnets on the wheel present opposite poles to these cores, constantly alternating currents are induced in these outer magnets. One series of terminals of the coils of these magnets is led to one binding post, while the other passes to a set of circuit-closing devices, by means of which all of the currents, separately or together, or any individual one or ones, may be conducted away from the machine.

The great merit of this second form of the Lontin machine lies in the facility with which currents varying in number and intensity may be derived from it, so that quite a number of electric lights may be produced at the same time, and also in the fact that in the conducting away of these currents, contact brushes are entirely dispensed with; so that the great loss in electricity attendant upon this mode of collection, besides the frequent attention required by its use, are entirely avoided.

With a velocity of rotation of 320 turns per minute, the machine being arranged so as to yield 12 separate currents, the outer magnets being connected together, two and two, for this purpose, 12 lights were obtained, each equivalent to 740 candles. Three series of 8 magnets each, gave 3 lights, each having an intensity of 1,480 standard candles.

It is said that to prevent any detriment to the machine arising from the conversion into heat of any currents that may not be required, while the remaining ones are being applied to some special purpose, these superflous currents are made to pass through appropriate resistance coils, and thus become, in a manner, absorbed.

A large Lontin machine, of the kind last described, was used at one time for lighting the railway depot at Lyons, where it fed 31 separate lamps, each giving out a light of about 340 candles. The power needed to run this machine is not stated. Another machine of this form, giving 24 lights of 1,480 candles, required from 20 to 22-horse power to drive it. Smaller machines of from 2,000 to 3,000 candles, demand somewhat more than five-horse power.

SIEMENS' NEW MACHINE.

Siemens and Halske have lately devised a new dynamo-electric machine, for the production of one or several independent currents, which may be made at pleasure, either intermittently, unidirectional or rapidly alternating in character.

In one form of this machine, the two sides of an upright iron frame carry, each, a series of 8 circularly disposed electro-magnets, the cores of which stand out at right angles to the sides, and carry at their ends, where they face the corresponding cores of the opposite series, large flat plates of soft iron. The plates of each set are alternately of opposite polarity, while those facing each other exhibit the same polarity; and as the space between them is made as small as the mode of construction will permit, magnetic fields of high intensity, and of alternately opposite polarity will come to be formed.

Upon a shaft running through the centre of the frame, there is secured a disc, carrying on its circumference an upright iron ring, oblong in section, made either of wire or plates, sometimes, also, of massive iron. This ring is surrounded at eight (or more, in some forms of the machine) equidistant places, by flat coils of insulated copper wire, which, with the ring, are carried by the rotation of the shaft through the magnetic fields formed by the electro-magnets. Two of the coils on the rotating ring

are devoted exclusively to the purpose of keeping the field magnets saturated, in accordance with the well-known dynamo-electric principle; and since the current in this case must be constant in direction, a special commutator is provided to secure this result. The alternating currents obtained from the remaining coils are conducted away from the machine by means of collars and brushes, in the ordinary manner.

The great resemblance of this machine to a machine of the Brush form, in which eight sets of electro-magnets are employed, instead of the usual two, need scarcely be pointed out.

Several forms of the machine above described are manufactured by Siemens and Halske, the details varying with the purposes to which it is intended to apply any particular machine. The larger machines possess one important distinctive feature, in that no iron is made use of in the construction of the revolving disc, the cores of the coils being formed of wood, or some other non-magnetic material. By this mode of arrangement the hurtful inductive effects, the production of Foucault currents, the loss of power by conversion into heat, and the like, attendant upon the use of iron in this connection, come to be entirely avoided.

In addition to the other forms or modifications of magneto-electric machines—by which name I intend to designate all that I have already described, as I do not think that the term dynamo-electric machines, to designate those in which electro-magnets, excited by the machine itself, are used as producers of the "field of force" or magnetic field in which the revolving magnets move, as distinguished from the earlier sort, using permanent magnets or the like, is at all necessary—there are some others which should not be passed over without notice.

In the first place, Mr. Edward Weston, of Newark, is manufacturing a machine resembling exactly in appearance, and, as far as I can see, in all essentials of construction, that which I have already described and shown as Siemens' later form (See Fig. 27.) With several of these machines I have made numerous trials lately, and find them to run well for as much as ten hours at a time, and to give a higher efficiency in light per horse power than any of the other machines with which I have

experimented. This result seems to agree with the general result of experiments made in Europe with the machines of Siemens, and with a general verbal statement which was made

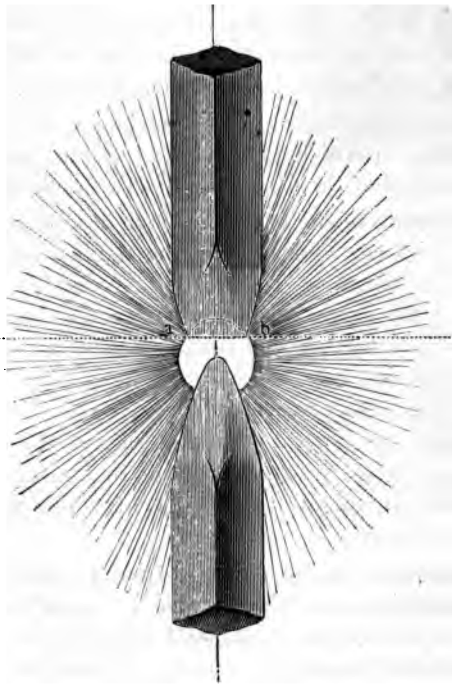


FIG. 40.

to me as to the result of experiments at the U. S. Torpedo Station, at Newport, R. I., where they have one of these Siemens machines.

There is also a very efficient machine manufactured by Messrs. Arnoux & Hochhausen, of New York. Some of these were used very successively last summer for lighting the bathing beach at Coney Island, and for lighting several points in New York during the holiday season, this winter, and the new State House at Albany during its inauguration.

One of these was kindly loaned to me on the evening of the address here reported, but as it was soon afterward required for use by its manufacturers I have not had an opportunity to

make any examination of, or experiments with it. It much resembles the second form of Wilde, or the Farmer machine in general arrangement.

In describing the various forms and modifications of these machines I have not attempted in all cases to follow the chronological order of each step, as this would sometimes have involved the skipping about from one type of machine to another. I will now, therefore, give an abstract of the chronology of the subject, following Dr. Schellen's book as an authority for a part of the list :

1831. Faraday discovered magneto-electric induction.
1832. Pixii made first magneto-electric machine.
1833. Saxton made magneto-electric machine.
1833. Clarke made magneto-electric machine.
1849. Nollett-Van Malderen—Alliance machine.
1852. Holmes improved construction of Alliance machine.
1857. Siemens introduced peculiar armature.
1864. Pacinotti, the first continuous current machine.
1866. Wilde made his first form of machine.
1866. Siemens & Halske, same principle as Ladd.
1867. Ladd, self-exciting principle.
1867. Wheatstone developed same principle.
1871. Gramme first described his continuous current machine.
1873. Wilde describes his second form.
1875. Siemens describes his machine. (Fig. 27.)
1873. Farmer patented machine like Wilde's second.
1874. Lontin machine, for many circuits,
1878. Gramme's alternating machine.

In considering the practical application of the electric arc as a source of light, it becomes very important to notice with accuracy just what is the chief location of light in the ignited poles, and how this may be affected by various conditions.

Thus, in the first place, if we are using a machine with a current of uniform direction, we will find that the upper or positive pole, as they are generally arranged, soon acquires a cup-shaped form, as shown in Fig. 40, and that the most intensely luminous portion of the carbon is the interior of this positive cup. The edges of this cup will evidently cut off this

light from spreading upward for a very considerable angle, while, on the other hand, all the light from this interior luminous area will pass freely downward. From this, it will of course follow, that very different results would be obtained if, with such machine and arrangement of the carbons, the lights were measured from below, or on a level, or from above.

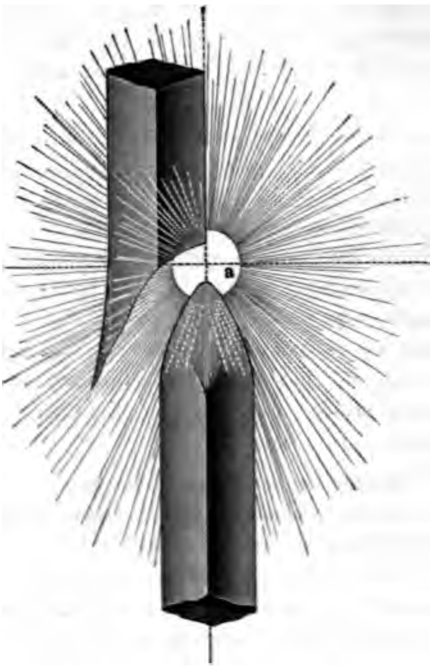


FIG. 41.

If the two carbon points are not placed truly in line with each other, then we have such a state of affairs as is shown in Fig. 41.

Here, evidently, while the light from the hollow positive pole would radiate freely in front, it would be largely cut off behind, and escape only with a medium degree of facility at either side ; in fact, measurements made with such arrangement show the following figures :

Representing by 100 the light emited, in a horizontal posi-

tion, when the points are in line, we have for the various directions, when they are displaced as shown in Fig. 41 :—In front, 287 ; laterally, 116 ; backward, 38.

In the report of experiments made by a committee of the Franklin Institute (see Journal of that Society, vol. 75, p. 301) I find the record of a similar set of measurements, as follows:

Front	2,218	candles.
Side	578	"
"	578	"
Back	111	"
	3,485÷4=871	

"The light produced by the machine, under the same conditions, except the carbons being adjusted in one vertical line, was 525 candles. This would seem to indicate that nearly 66 per cent. more light was produced by this adjustment of the carbons; but a close study of the conditions satisfied us that such is not the case, and that there is no advantage to be derived from such adjustment, except when the light is intended to be used in one direction only."

This shows us, among other things, how very great a difference of result in candle power may be obtained with the same apparatus, if a difference occurs in the arrangement of the points ; and it also explains why an arc, which gives a very high candle power when measured, may quite fail to exhibit anything like an equal degree of actual illuminating power when put to some practical use.

Thus, in the case just cited, while the candle power, measured from the front, would be 287, the average for all directions would be only 139, or about one-half as great.

In this connection a certain advantage is found in the use of machines with alternating currents. Here the carbons both burn away alike to pointed ends, and the light is thus much more equally distributed on all sides. [See Fig. 42.]

In most of the machines now in use, the current which produces the light is the same which passes around the coils of the stationary magnets, by which the field of force is developed;

hence, there is the most intimate relation between the machine and the lamp, and any fluctuation in the resistance offered at the latter, is at once felt at the machine. To eliminate this source of uncertainty and irregularity, in some experiments which I have lately conducted with various machines, I have employed a simple, substantial holder for the carbons, with means of adjustment from time to time, by hand. This requires,

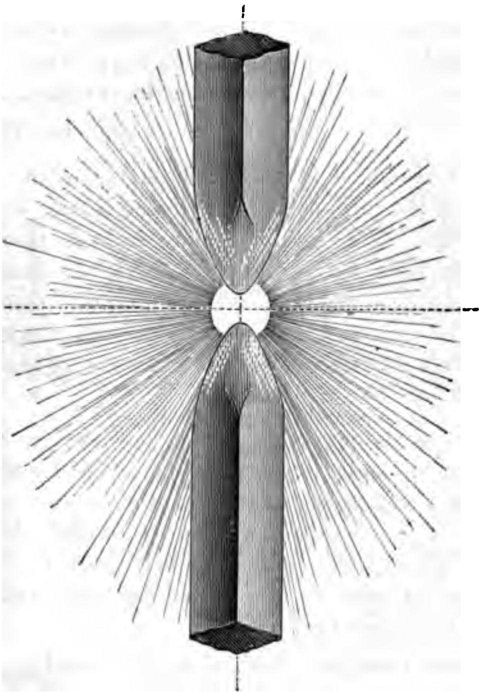


FIG. 42.

of course, the frequent attention of an assistant during the experiments, but by this means I have obtained more constant and favorable results from all the machines tried, than with any of the automatic lamps.

Next to this, I have found the Siemens lamp, and after it, that of Brush to be the most satisfactory, when used each with its own machine.

As the structure of the Brush lamp is very simple, I will give a description of it here.

This lamp is shown in Figs. 43 and 44, in which *a* is a helix of insulated copper wire, resting upon an insulated plate, *b*, upheld by the metallic post, *c*. Loosely fitted within the helix is the core, *d* partly supported by the adjustable springs, *e*. The rod, *f*, passes freely through the centre of the core, *d*, and has as its lower end a clamp for holding the carbon pencil. A washer, *h*, of brass, surrounds the rod, *f*, just below the core, *d*, and has one edge resting on the lifting finger attached to the latter, while the other edge is overhung by the head of an adjustable screw stop, *x*.

The metal post, *c*, is supported and guided by a tubular post, *i*, secured to a suitable base plate. Attached to the lower end of the post, *c*, and passing out through a slot in *i*, is the arm, *y*, supporting an insulated holder for the lower carbon.

If, now, one conducting wire from the machine be connected to the base plate, and the other to the lower carbon holder, the current of electricity will pass up through the posts, *i* and *c*, through the helix, *a*, rod, *f*, and the carbons, *kk*, thus completing the circuit.

The axial magnetism produced in the helix will draw up the core, *d*, and it, by means of the lifting finger, will raise one edge of the washer, *h*, which, by its angular impingment against the rod, *f*, clamps and lifts it to a distance controlled by the adjustable stop, *x*, but separating the carbon points far enough to produce the light.

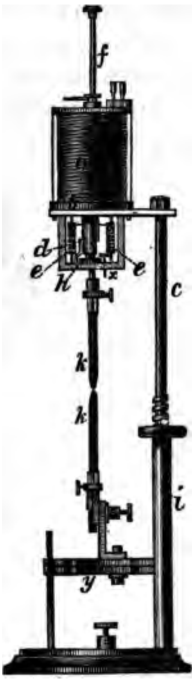


FIG. 43.

As the carbons burn away, the increased length of the electric arc increases its resistance, and weakens the magnetism of the helix, and therefore the coil, rod, and carbon move downward by the force of gravity until, by the shortening of the arc, the magnetism of the helix is strengthened, and the downward movement arrested. When, how-

ever, the downward movement is sufficient to bring the clutch-washer, *h*, to the support, *g*, it will be released from the clamping effect of the lifting finger, and the rod *f*, will slip through until arrested by the upward movement of the core, due to the increased magnetism of the helix.

The normal position of the clamp-washer is with the edge under the adjustable stop, just touching the support, *g*, the office of the core being to regulate the slipping of the rod through it. If, however, the rod, from any cause, falls too far, it will instantly and automatically, be raised again, as at first, and the carbon points thus continued at the proper distance from each other.

In the lamps used in these experiments, the helix was composed of two separate insulated wires wound together so that, by means of suitable pin contacts, shown at the top of Fig. 10. they could be connected either in couples or end to end, thus

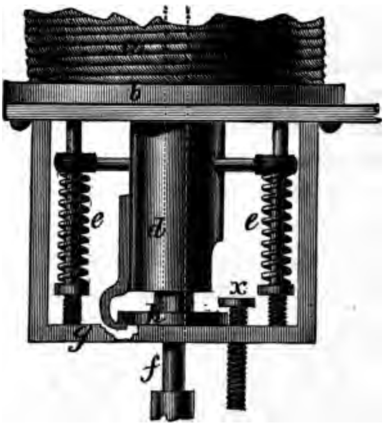


Fig. 44.

varying the intensity of the magnetism of the helix. Thus, in connection with varying the weight to be lifted by the magnetism of the helix, either by loading the core or increasing the upward thrust of the springs, we are enabled to adjust the lamp to suit the varying qualities of the currents dealt with.

Several new methods of arranging the carbons, and render-

ing them more or less adjustible automatically, have been recently suggested or put in practice.

Thus, in *Nature*, for Dec. 19th, 1878, I find a plan described by Wilde, which consists in placing two carbon rods beside each other, as in the Jablochkoff candle, but without any insulating material between them. Under these circumstances the author states that the arc will keep to the extremities of the rods, or will run to them if established elsewhere.

To provide against extinction, and secure automatic-relighting, one of the holders is hinged so as to allow its carbon to fall against the other unless pulled away by an electro-magnet in circuit. This arrangement is certainly very simple, and free from many of the objections offered in connection with the Jablochkoff candle. It will be seen here, however, that the maximum light will be developed between the two rods, or, in other words, on their respective inner surfaces where it will have the least facility for producing useful effect.

A very curious modification of this candle has been made by Mr. Edward Weston, in which he places a strip of some relatively volatile matter on the backs or outer sides of the parallel carbon rods. The arc then forms across from these parts, and the incandescent vapor assumes much the appearance of a gas flame.

Among the recent forms of lamp described in Dr. Schellen's recent work, "Die Magnet-und Dynamo-Elektrischen Maschinen," are several announced by the Siemens-Halske firm.

In one of these, two carbons inclined towards each other, are allowed to descend, and thus bring their upper ends together by the withdrawal downwards of a non-conducting interposed rod, whose motion is controlled by an electro-magnet in the circuit.

In another, which, however, looks like a suggestion rather than a practicable machine, the carbons are arranged so that the lower one is constantly vibrating up and down, and the upper one simply rests upon it, except in so far as it is being constantly knocked away by the motion of the lower one, which motion is affected by an electro-magnet in the circuit.

A much more complete apparatus, on the same general principle, we will describe presently.

Among the latest developments in electric lamps, may be reckoned the plan of Mr. Werdermann, which may be described as follows:

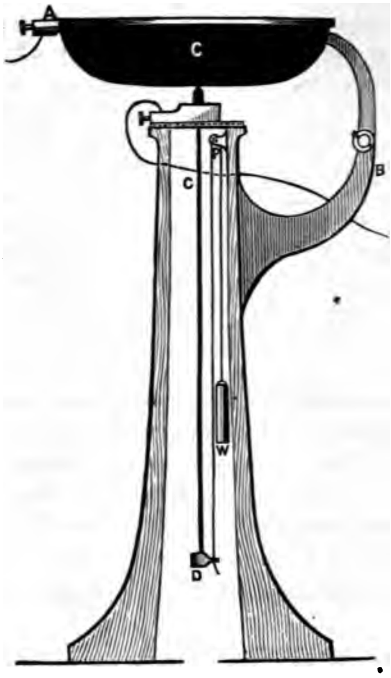


FIG. 45.

Mr. Werdermann makes one electrode to consist of a disc of carbon, tapering in thickness from the centre to the circumference on one side, and flat on the other. The other electrode is a very fine and thin rod of carbon, with one end pointed. The disc is placed horizontally with the rounded side downwards, and the thin rod vertically, and in contact with the disc, the current being supplied *via* the metal collar, by which the rod is supplied near the top. On passing the electricity the fine point of the carbon rod, above the collar, becomes incandescent, and a very small electric arc is produced between the

two carbons. Referring to the diagram (Fig. 45), the upper carbon is shown at C, and the rod at *c*. The former is supported by means of an adjustable jointed bracket *b*, attached to the wood stand. The rod carbon is guided by the spring collar on the top of the stand, and to which the connection is made, and is supported by the fine cord, running over the pulley, *p*. This cord is attached to the clasp, *d*, at the bottom of the rod, and to the balance weight, *w*, by which the rod is maintained in constant, practical, though not absolute contact with the disc. Round the upper part of the disc is a metal band, *a*, to which the circuit wire is attached, and the current thus passed on to the next lamp.

"This lamp," says the *Ironmonger* of Nov. 9, "was tried on October 28, and again on November 6, on the works of the British Telegraph Manufactory (Limited), Euston Road, London, the current being derived from a small Gramme machine of two-horse power. At the commencement two lights were maintained equal to 640 candles, and the light was perfectly steady. Subsequently the current was sent through a row of 20 lamps, the light of each being equal to 40 candles ; still the light was steady. Mr. Werdermann asserted his ability to distribute the current from the small machine then at work, so as to divide it among 60 lights. In that case the light would inevitably be small; but enough is apparent to prove that, so far as a current will bear division, Mr. Werdermann will be able to utilize it."

It will be noticed that here, as with all other lamps working by incandescence, there is a great loss, which increases with the subdivision. A Gramme machine utilizing two-horse power, should give, with an ordinary lamp, a light of from 1,000 to 1,500 candles, in place of the 640 here claimed from two lamps, or the 400 candles claimed for ten lamps.

A yet more recent system, is that developed, or, we might rather say, now in the course of development, by Profs. Elihu Thomson and Edward Houston, of Philadelphia, which they have themselves described as follows :

" As is well known, when an electrical current, which flows through a conductor of considerable length, is suddenly broken,

a bright flash, called the extra spark, appears at the point of separation. The extra spark will appear, although the current is not sufficient to sustain an arc of any appreciable length at the point of separation.

"In our system, one or both of the electrodes, which may be the ordinary carbon electrodes, are caused to vibrate to and from each other. The electrodes are placed at such a distance apart that in their motion toward each other they touch, and afterward recede a distance apart, which can be regulated. These motions or vibrations are made to follow one another at such a rate that the effect of the light produced is continuous; for, as is well known, when flashes of light follow one another at a rate greater than 25 to 30 per second, the effect produced is that of a continuous light. The vibratory motions may be communicated to the electrode by any suitable device, such for example, as mechanism operated by a coiled spring, a weight, compressed air, etc.; but it is evident that the current itself furnishes the most direct method of obtaining such motion, as by the use of an automatic vibrator, or an electric engine.

"In practice, instead of vibrating both electrodes, we have found it necessary to give motion to but one, and since the negative electrode may be made of such size as to waste very slowly, motion is imparted to it, in preference to the positive. The carbon electrodes may be replaced by those of various substances of sufficient conducting power. In this system, when desired, an independent battery circuit is employed to control the extinction and lighting of each lamp.

"The following is a description of one of the forms of electric lamp which we have devised, to be used in connection with our system of electric lighting:

"A flexible bar, *b*, of metal is firmly attached at one of its ends to a pillar, *p*, and bears at its other end an iron armature, *a*, placed opposite the adjustable pole-piece of the electro-magnet, *m*. A metal collar, *c*, supports the negative electrode, the positive electrode being supported by an arm, *j*, attached to the pillar, *p*. The pillar, *p*, is divided by insulation at *i* into two sections, the upper one of which conveys the current from the binding post, marked +, to the arm, *j*, and the rod, *r*, supporting the positive electrode.

"The magnet, *m*, is placed as shown by the dotted lines, in the circuit which produces the light. The pillar, *p*, is hollow, and has an insulated conducting wire inclosed, which connects the circuit closer, *v*, to the binding post, marked —. The current is conveyed to the negative electrode through *b* and the coils of the magnet *m*. When the electrodes are in contact,

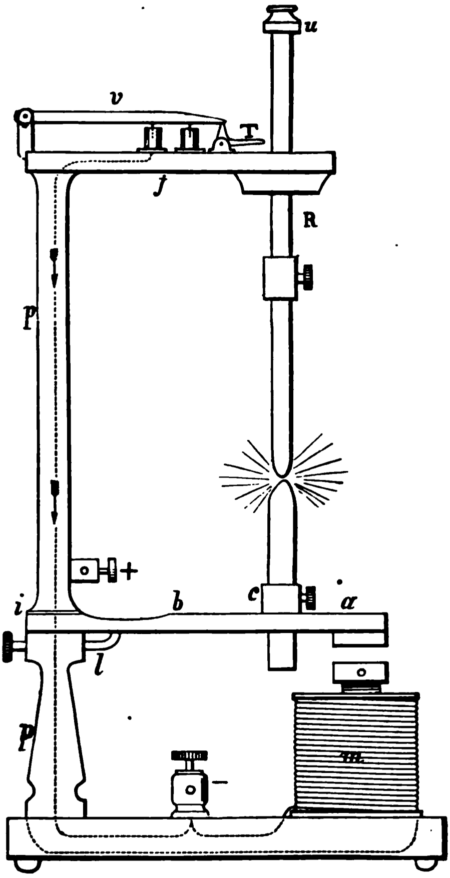


FIG. 46.

the current circulating through *m* renders it magnetic and attracts the armature, *a*, thus separating the electrodes, when, on the weakening of the current, the elasticity of the rod, *b*, again

restores the contact. During the movement of the negative electrode, since it is caused to occur many times per second, the positive electrode, though partially free to fall, cannot follow the rapid motions of the negative electrode, and therefore does not rest in permanent contact with it. The slow fall of the positive electrode may be insured either by properly proportioning its weight, or by partly counterpoising it. The positive electrode thus becomes self-feeding.

"The rapidity of movement of the negative carbon may be controlled by means of the rigid bar, *l*, which acts, practically, to shorten and lengthen the part vibrating. In order to obtain an excellent but free contact of the arm, *j*, with the positive electrode, the rod, *r*, made of iron or other suitable metal, passes through a cavity filled with mercury, placed in electrical contact with the arm, *j*. Since the mercury does not wet the metal rod, *r*, or the sides of the opening through which it passes, free movement of the rod is allowed without any escape of the mercury. We believe that this feature conld be introduced advantageously into other forms of electric lamps.

"In order to prevent a break from occurring in the circuit when the electrodes are consumed, a button, *v*, is attached to the upper extremity of the rod, *R*, at such a distance that when the carbons are consumed as much as is deemed desirable, it comes into contact with a tripping lever, *t*, which then allows two conducting plugs, attached to the bar, *v*, to fall into their respective mercury cups, attached, respectively, to the positive and negative binding posts by a direct wire. This action practically cuts the lamp out of the circuit."

"PHILADELPHIA, Sept. 19, 1878."

In a later publication (Journal of the Franklin Institute for January, 1879), the same inventors describe a further modification and extension of their system, as follows :

"The following apparatus was devised by the authors for the purpose of obtaining induced reversed currents for use in electric illumination. These currents we use with a vibrating lamp, a description of which has already been published.

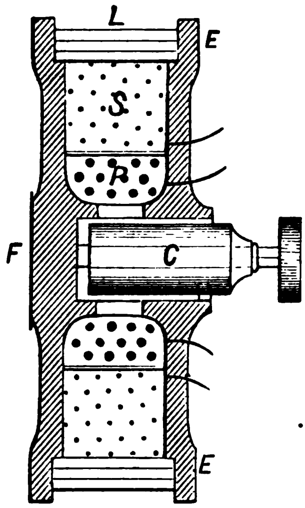


FIG. 47.

"Our method of operation is as follows:—A reversed primary current is caused to induce reversed secondary currents in secondary coils provided therefor. These secondary currents are caused to give vibrations to carbon electrodes, and thereby at the same time produce a partial arc between them. With sufficient strength of primary current, a considerable number of secondary currents are obtained, each of which is able to operate one of our vibrating lamps.

"The use of a vibrating lamp admits of a wide range in the size of the carbons employed. When a light of very moderate intensity is desired, the carbons are made of very small size, and are placed in a closed glass vessel for protection from the atmosphere. To moderate the brilliancy opalescent glass is used. To obtain the highest efficiency of inductive action from a set of primary coils, the following form of induction of coil was devised:—the primary coil, *P*, surrounding the core, *C*, is provided with a secondary coil, *S*, adjacent to it. The ends *E* and *F* of the bobbin are made of disks of iron concentric with the core, *C*, and slit from centre to circumference. The outer extremity of these disks are connected by wires or sheets of iron, *L*, to one another, forming in this manner an induction coil encased in iron, or one whose core has its north and south extremities magnetically connected. The strength of the current developed in the secondary coil is greatest when the core, *C*, which is movable, is inserted so that both of its extremities are in contact with *E* and *F*. By withdrawing this core, the currents in the secondary coil may be weakened to almost any desired extent. This coil is best adapted to the use of primary currents whose direction is constantly changing. All the wire being completely surrounded by iron, whose direction of magnetic pola-

rization if rapidly changed, the highest inductive effect is thereby produced in the secondary coil.

"The variations in the intensity of the induced currents will, of course, be followed by variations in the intensity of the light emitted by the lamp. The movement of the core may therefore be made to increase or decrease the intensity of the light."

With this notice of the newest, or, as we may say, youngest system of electric lighting, which has its birthday with the new year, I may well conclude this hastily prepared and imperfect notice of this very interesting subject, and if what I have here thrown together may supply, at least, material for a fuller treatment, or a skeleton on which a completely organized structure may be constructed, I shall have accomplished all I could hope.

Before concluding this address, I should draw attention, in a more direct manner, to something which has been developed indirectly in the course of my remarks; and that is, that the loss of efficiency in the electric force as a means of producing light, when it is divided, is not a unique phenomenon, but is exactly paralleled in the case of ordinary combustion.

If gas is burned in very small flames, we may get almost no light from it, and, on the other hand, if we burn it in very large flames, the amount of light developed will increase in a much higher ratio than will the amount of gas consumed.

Thus, I have here a new burner made by Sugg, of London, with three concentric argand rings, which burn 30 feet of gas, and yields a light equal to 196·4 candles. The same amount of the same gas burned in six standard five foot burners, yielded a light of 114 candles. Here is a gain of over 70 per cent. in the total light produced, by simply concentrating the combustion in one large flame, in place of dividing it into six small ones.

In the case of the ordinary lime-light, we have another instance of yet further concentration.

Here, with a consumption of about 7½ feet of gas an hour, in a burner with three jets, heating a cylinder of lime from all sides, we obtain a light equal to 260 candles in every direction,

This shows very clearly the illogical character of the comparisons so often made between the concentrated light of the electric arc, and the divided light of the ordinary gas burner.

Heretofore, electric lights have only been practically developed in their *concentrated* form, and it certainly has *not* yet been shown that, when divided there will fail to be an enormous loss of efficiency. Gas, on the contrary, has heretofore only been practically used in its *divided* form, and there can be no doubt that its efficiency is capable of much increase when it is burned in a concentrated manner.

It is here where the actual contest will come in, and the relative success of the two sources of light in each field, will depend upon what it will accomplish in that field, and not in some other. In other words, we must compare the divided electric lights (say Mr. Edison's, when they become visible) with ordinary burners, and the electric-arc light with the lime-light, or some such concentrated form of gas burning.

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CONSTITUTION

OF THE

AMERICAN GAS LIGHT ASSOCIATION.

I. The name of the Association shall be THE AMERICAN GAS LIGHT ASSOCIATION, and its office shall be in the City of New York.

II. The objects of this Association shall be—the promotion and advancement of knowledge, scientific and practical, in all matters relating to the construction and management of gas works, and the manufacture, distribution and consumption of illuminating gas, to the end that its cost may be cheapened and its consumption increased.

2. The establishment and maintenance of a spirit of fraternity between the members of the Association, by social intercourse, and by friendly exchange of information and ideas on the before-mentioned subject matters.

3. The inducement and extension of more cordial and friendly relations between the manufacturers of illuminating gas and their patrons, based upon mutuality of interests and a recognition by both of the fact that each have rights which the other should respect.

III. The members of this Association shall consist of two classes, active members and honorary members.

IV. *To be eligible as an active member a person must be a president, vice-president, director, secretary, treasurer, engineer, consulting engineer, or superintendent of a gas company, or an individual manager of a gas works, or a person practically skilled in the construction and management of gas works.*

V. Honorary members shall be gentlemen whose scientific or practical knowledge in matters relating to the gas industry, and whose efforts and interests in that behalf, shall recommend them to the Association.

VI. Every applicant for active membership shall signify the same in writing to the Secretary, addressed to the Association, indorsed by two active members.

VII. Honorary members shall be proposed to, or by the Executive Committee, and notice thereof shall be given by the Secretary to the Association for its action. The election of applicants for active membership, and of persons proposed as honorary members, shall be by ballot, and each person shall receive two-thirds of the vote cast to be elected.

VIII. New members shall be formally introduced to the Association by the presiding officer after being elected, when they shall subscribe their names to the Constitution of the Association, in a roll book of the same, and they shall each, at the same time, receive a copy of the Constitution and By-Laws of the Association.

IX. If any applicant for membership, or person proposed for membership, on being balloted for, be rejected, no notice shall be taken of the application or action on the same in the minutes.

X. The affairs of the Association shall be managed by an Executive Committee, subject to the control of the Association, by its action in general meetings. The Executive Committee shall be composed of the officers of the Association for the time being, and the President or Acting President for the last preceding year. All questions in Executive Committee shall be decided by a majority vote, and five members shall be a quorum.

XI. The officers shall consist of a President, three Vice-Presidents, Treasurer and Secretary, to be elected annually, by ballot, six members of Executive Committee, and three members of Finance Committee.

XII. The officers of the Association shall assume office immediately after the close of the meeting at which they are elected; they shall hold meetings at the call of the President, or in his absence, at the call of the Vice-President, and make arrangements for carrying out the objects of the Association.

XIII. The President, or in his absence one of the Vice-Presidents, shall preside at all meetings of Association and Executive Committee at which he is present.

XIV. The duties of the Treasurer shall be to receive, and safely keep, all annual dues and funds of the Association ; to keep correct accounts of the same, and pay all bills approved by the President or a member of the Finance Committee ; and he shall make an annual report to be submitted to the Association.

XV. The duties of the Secretary shall be to take minutes of all proceedings of the Association, and of the Executive Committee, and enter them in proper books for the purpose. He shall conduct the correspondence of the Association ; read minutes and notices of all the meetings ; and also papers and communications, if the authors wish it, and perform whatever duties may be required in the Constitution and By-Laws appertaining to his department.

XVI. The Finance Committee shall meet on the day of each annual meeting of the Association, at least one hour before the opening of the meeting, to receive from the Treasurer a statement of his accounts, and audit the same. They shall hold such other meetings from time to time as the interests of the Association may require.

XVII. The annual meeting of the Association shall be held in the City of New York on the third Wednesday of October of each alternate year. Other general meetings of the Association may be held at such times and places as shall be directed at the previous annual meeting.

XVIII. At the annual meeting of the Association the order of business shall be:

1. The reading of the minutes of the last meeting.

2. The reading of applications, notices and reports for new membership.

3. The election and introduction of new members.

4. The address of the President.

5. The report of Executive Committee on the management of the Association during the previous year.

6. The report of the Treasurer.

7. The report of the Finance Committee.

8. Reports of special committees.

9. The election of officers.

10. The reading of papers, of which notice has been given to members by the Secretary, and discussions upon the same.

11. General business.

XIX. At other general meetings of the Association, the order of business shall be the same, except as to the 5th, 6th, 7th, and 9th clauses.

XX. The secretary shall send notices to all members of the Association at least fourteen days before each general meeting, mentioning the papers to be read, and any special business to be brought before the meeting.

XXI. The Executive Committee shall meet one hour before each general meeting of the Association, and on other occasions when the President shall deem it necessary; of which special meetings reasonable notice shall be given by special call in print or writing, specifying the business to be attended to.

XXII. All questions shall be decided by any convenient system of open voting, the presiding officer to have a second or casting vote when necessary.

XXIII. Questions of special nature shall be decided by ballot.

XXIV. Any member, with the concurrence of the presiding officer, may admit a friend to each meeting of the Association, but such person shall not take any part in the discussion unless permission to do so be given by the meeting.

XXV. All papers read at the meetings of the Association must relate to matters either directly or indirectly connected

with the objects of the Association, and must be approved by the Executive Committee before being read, unless notice of the same shall have been previously given to the members by the Secretary.

XXVI. All papers, drawings or models submitted to the meeting of the Association shall be and remain the property of the authors.

XXVII. *Active members shall pay an initiation fee of ten dollars, and the sum of five dollars annually thereafter, which shall be paid in advance.*

XXVIII. No member whose annual payment shall be in arrears shall be entitled to vote.

XXIX. Honorary members shall not be required to make any payments or contributions to the Association.

XXX. Any member may retire from membership by giving written notice to that effect to the Secretary, and the payment of all annual dues to that date ; but he shall remain a member and liable to the payment of annual dues till such payments are made.

XXXI. Any member may compound for his annual payments, paying fifty dollars in one sum.

XXXII. A member may be expelled from the Association by a report and motion to that effect made by the Executive Committee, at any general meeting of the Association ; the vote shall be by ballot, and shall require two-thirds of the votes cast for its adoption.

AMENDMENTS.

XXXIII. All propositions for adding to, or altering any of the provisions of the foregoing Constitution, shall be laid before the Executive Committee, who may bring it before the next general meeting of the Association, if they think fit, and such committee shall be bound to do so on the requisition in writing of any five members of the Association. Each member of the Association shall, upon request, be furnished by the

Secretary with a copy of the Constitution and By-Laws of the Association, and also a list of the names and residences of the members.

At the Annual Meeting, held on the 16th, 17th, and 18th days of October, 1878, the following amendments were proposed and laid before the Executive Committee, and will be brought before the Association for action at the meeting to be held at Philadelphia, in October, 1879.

CHARLES NETTLETON,
Secretary.

On Motion, Further recommended to amend Art I. of the Constitution, by striking out the last clause, leaving it as follows: "The name of the Association shall be The American Gas Light Association."

On Motion, Also, that Sec. XVII. be amended, by striking out "In the City of New York," etc., leaving it as follows: "The Annual Meeting of the Association shall be held on the 3d Wednesday of October, of each year, at 10 o'clock, A. M., at such place as shall be designated by the Association at the previous annual meeting."

Also, Amend Art. XXVIII., so as to read: "No member who shall be two years in arrears shall be entitled to vote, or to participate in the the deliberations of the Association."

Also, To Amend Section XI., by adding to the same the following: "And that a change of at least one vice-president, one member of the finance committee and two members of the executive committee, be made at each annual meeting of the Association."

REPORT OF TREASURER

OF THE

AMERICAN GAS LIGHT ASSOCIATION,

For the Year ending October, 16, 1877.

CHARLES NETTLETON, *Treasurer,*

In account with AMERICAN GAS LIGHT ASSOCIATION.

1876.	Dr.		
October 17.	To Cash balance on hand..........................		$365 97
	" " of Hugh McLean,	1877	5 00
	" " J. Pearson Gill,	1876	5 00
	" " I. N. Stanley,	"	5 00
	" " " "	1877	5 00
18.	" " William G. Gardner,	1876	5 00
	" " " "	1877	5 00
	" " Emerson McMillen,	"	5 00
	" " M. M. Diall, Initiation fee..........		10 00
	" " Patrick J. Salmon, "		10 00
	" " Thos. C. Hopper, "		10 00
	" " Chas. E. James, "		10 00
	" " W. H. Linton, "		10 00
	" " B. E. Lehman, "		10 00
	" " Philip Peebles, "		10 00
	" " J. F. Rogers, "		10 00
	" " W. H. Perry, "		10 00
	" " M. Harrington, "		10 00
	" " Geo. H. Wells, "		10 00
	" " James Williams, "		10 00
	" " Chas. C. Van Benschoten, ...		10 00
	" " Edward Lindsley, Initiation fee......		10 00
	" " John Andrew, "		10 00
	" " T. F. White, "		10 00
	" " J. C. Tiffany, "		10 00
	" " I. Herzog, "		10 00

DUES FOR THE YEAR ENDING OCTOBER, 1877.

October 18.	To	Cash of	C. S. Allmand,	$5 00
	"	"	W. H. Bradley	5 00
	"	"	W. H. Baxter	5 00
	"	"	Geo. D. Cabot	5 00
	"	"	Matt Cartwright	5 00
	"	"	Thomas Turner	5 00
	"	"	O. E. Cushing	5 00
	"	"	E. S. Cathels	5 00
	"	"	H. Cartwright	5 00
	"	"	Thos. C. Cornell	5 00
	"	"	Wm. Cartwright	5 00
	"	"	Charles Roome	5 00
	"	"	George Richardson	5 00
	"	"	A. B. Slater	5 00
	"	"	Isaac R. Scott	5 00
	"	"	C. F. Smith	5 00
	"	"	James M. Starr	5 00
	"	"	F C. Sherman	5 00
	"	"	Henry Stacey	5 00
	"	"	O. G. Steele	5 00
	"	"	C. White	5 00
	"	"	Gideon Wood	5 00
	"	"	Wm. L. Williams	5 00
	"	"	A. C. Wood	5 00
	"	"	Robert Young	5 00
	"	"	W H. Miller	5 00
	"	"	John Balmore	5 00
	"	"	Isaac Battin	5 00
	"	"	John H. Cowing	5 00
	"	"	John Cartwright	5 00
	"	"	William Helme	5 00
	"	"	Edwin Keith	5 00
	"	"	George Dwight	5 00
	"	"	Justus Dittmar	5 00
	"	"	F. J. Davis	5 00
	"	"	F. W. Gates	5 00
	"	"	L. P. Gerould	5 00
	"	"	J. P. Harbison	5 00
	"	"	L. C. Hanford	5 00
	"	"	John W. Bates	5 00
	"	"	A. C. Humphreys	5 00
	"	"	S. A. Hickey	5 00
	"	"	T. Littlehales	5 00
	"	"	P. Munzinger 1876	5 00
	"	"	P. Munzinger	5 00

October 18.	To Cash of	L. G. McCauley		$5 00
	" "	R. J. Monks		5 00
	" "	Lewis Moss		5 00
	" "	Geo. B. Neal		5 00
	" "	C. H. Nettleton		5 00
	" "	F. H. Odiorne		5 00
	" "	T. J. Pishon		5 00
	" "	Samuel Pritchitt		5 00
	" "	W. H. Pearson		5 00
	" "	W. H. Price		5 00
	" "	Thos. F. Rowland		5 00
	" "	Benjamin Rankin		5 00
	" "	J. H. Rollins		5 00
	" "	Metropolitan Gas Light Co.,	1877	5 00
	" "	Emerson McMillin,	1877	5 00
	" "	Peoples Gas Co. of Cleveland,	1877	5 00
	" "	W. H. Turner		5 00
	" "	W. H. White,	"	5 00
	" "	St. Paul Gas Light Co.,	1875	5 00
	" "	" " " " "	1876	5 00
	" "	" " " " "	1877	5 00
	" "	Philip Peebles,	1878	5 00
Nov. 3.	" "	N. B. Crenshaw,	1877	5 00
	" "	George W. Edge	"	5 00
4.	" "	William D. Caldwell	"	5 00
6.	" "	Corning Gas Light Co.,	1876	5 00
	" "	" " " "	1877	5 00
8.	" "	W. H. Warner	"	5 00
	" "	H. F. Coggshall	"	5 00
9.	" "	Thomas R. Brown	"	5 00
	" "	James Somerville	"	5 00
	" "	Thomas D. Gilbert	"	5 00
10.	" "	J. N. Coldren,	"	5 00
	" "	Theobold Forstall	"	5 00
13.	" "	William B. Cleland	"	5 00
14.	" "	S. L. Wiley	"	5 00
17.	" "	W. W. Goodwin	"	5 00
	" "	J. M. Sterling	"	5 00
	" "	Eugene Printz	"	5 00
20.	" "	J. Simpson Africa	"	5 00
	"	San Antonio Gas Light Co	1876	5 00
21.	" "	Joseph Hendly	1877	5 00
22.	" "	Meriden Gas Light Co	"	5 00
23.	" "	George K. Reed	"	5 00
	" "	Edward L. Wood	"	5 00
Dec. 4.	" "	Edward Jones	"	5 00
9.	" "	F. A. Sabbaton	"	5 00
11.	" "	Dunkirk Gas Light Co	"	5 00

Dec.	11.	To Cash of	John Green	1877	$5	00
	14.	" "	C. F. Maurice	"	5	00
	15.	" "	William B. Durfee	"	5	00
		" "	R. Spencer	"	5	00
		" "	Hiram Merrill	"	5	00
	21.	" "	William Farmer, initiation fee	"	10	00
	29.	" "	Washington City Gas Light Co.		5	00
1877.						
January	9.	" "	Eugene Vanderpool	1877	5	00
Feb.	12.	" "	L. M. Moyes	1875	5	00
		" "	L. M. Moyes	1876	5	00
		" "	L. M. Moyes	1877	5	00
March	20.	" "	Moses Coombs, Jr	"	5	00
April	13.	" "	Adrian Gas Light Co	"	5	00
May	16.	" "	Horatio P. Allen	"	5	00
July	21.	" "	H. A. Brooke	"	5	00
	23.	" "	Easton Gas Light Co	"	5	00
	24.	" "	James How	"	5	00
		" "	Edwin Ludlam	"	5	00
	25.	" "	Bloomington Gas Light Co	"	5	00
		" "	John W. Newell	"	5	00
	26.	" "	Chicago Gas Light Co	"	5	00
		" "	A. G. Guerard	"	5	00
		" "	George S. Hookey	"	5	00
	27.	" "	James R. Floyd	"	5	00
August	6.	" "	John C. Buxton	"	5	00
		" "	Easton Gas Light Co	1876	5	00
	8.	" "	Dorchester Gas Light Co	1877	5	00
	16.	" "	Titusville Gas Co	"	5	00
		" "	R. Spencer	1878	5	00
	17.	" "	David H. Fox	1877	5	00
		" "	Fred S. Benson	"	5	00
	20.	" "	Coldwater Gas Light Co	1876	5	00
		" "	R. W. Wilder	1877	5	00
	21.	" "	O. G. Steele	1878	5	00
	23.	" "	H. H. Fish	1877	5	00
	24.	" "	Copy Volume 2. Sold		2	00
	27.	" "	Marcus Smith	1877	5	00
		" "	Marcus Smith	1878	5	00
		" "	Charles W. Isbell	1876	5	00
		" "	Charles W. Isbell	1877	5	00
	30.	" "	Copy Volume, 2. Sold		2	00
Sept.	4.	" "	J. Desha Patton	1877	5	00
	5.	" "	Tarrytown & Irvington Gas Light Co	1875	5	00
		" "	Tarrytown & Irvington Gas Light Co	1876	5	00

Sept.	5.	To Cash of	Tarrytown & Irvington Gas Light Co 1877	$5 00
	6.	" "	Copy Volume 2. Sold..............	2 00
		" "	Copy Volume 2. Sold..............	2 00
		" "	Copy Volume 1. Sold..............	1 40
	18.	" "	Copy Volume 2. Sold..............	2 00
	19.	" "	William Heilman, initiation fee......	10 00
	22.	" "	George Buist......................1878	5 00
		" "	Chas. A. Gerdenier...............1877	5 00
Oct.	1.	" "	Albert D Perry....................1877	5 00
		" "	Albert D. Perry..................1876	5 00
	5.	" "	Copy Volume 2. Sold..............	2 00
	6.	" "	John S. Chambers...............1878	5 00
	12.	" "	T. F. White...................... "	5 00
		" "	David W. Crafts..................1877	5 00
		" "	F. C. Sherman...................1878	5 00
	13.	" "	Copy Volume 2. Sold..............	2 00
		" "	Charles Nettleton 1877	5 00
				$1,336 37

1876			Cr.	
Oct.	30.	By Cash paid	rent of Chickering Hall for October 18th and 19th for annual meeting	$100 00
Nov.	4.	" "	Postage stamps	3 00
		" "	Postal cards............................	1 00
1877.				
April	20.	" "	Express charges........................	30
May	7.	" "	Express charge on Package from Hartford	25
	12.	" "	Express charge on Package to Hartford	30
	22.	" "	Copy Book	1 50
June	25.	" "	Express on box of Electrotypes	35
July	17.	" "	Express on package to Hartford....	25
		" "	Telegram from Hartford............	25
	18.	" "	Postage	2 00
	25.	" "	Postage	2 00
Aug.	6.	" "	Telegram to Cincinnati.............	25
		" "	Telegram from Cincinnati...........	25
	9.	" "	Freight from Hartford	70
		" "	Porter for bringing box up..........	25
		" "	Postage stamps.......................	18 00
		" "	Ball of twine..........................	25
	13.	" "	Freight from Hartford...............	75
		" "	Porter for bringing box up..........	50
	14.	" "	Postage stamps.......................	1 00

Aug.	15.	By Cash for Postal cards........................	$2 00
	18.	" " Postage stamps........................	3 00
	21.	" " Freight from Hartford................	60
	25.	" " Postage stamps........................	2 00
	28.	" " Case, Lockwood & Brainerd Co., printing 500 copies proceedings....	581 45
Sept.	1.	" " Circular envelopes (500)	6 00
	4.	" " Postage stamps........................	2 00
	10.	" " Telegram	25
		" " Postal envelopes......................	2 00
	11.	" " Freight from Hartford................	70
	12.	" " Circular envelopes...................	2 20
	15.	" " A. M. Callender & Co., printing circulars	3 50
	20.	" " Postage stamps........................	1 00
	21.	" " R. Lane, cutting down books.........	1 00
	24.	" " Postage stamps........................	1 00
Oct.	2.	" " Postage stamps........................	2 00
		" " Case, Lockwood & B. Co., bill of printing	33 10
	6.	" " Postal cards..........................	2 00
	11.	" " E. P. Coby & Co., printing...........	13 10
		" " Rent of parlor, Hoffman House, for meeting in 1876	20 00
	12.	" " Refund of initiation fee, F. C. Sherman	5 00
	13.	" " Charles Nettleton, Treasurer's salary one year............................	350 00
		" Balance to new account..................	169 32
			$1,336 37

SYNOPSIS.

Cash on hand last report..................................		$365 97
" Received for initiation fees............................		200 00
" Received for annual dues................................		755 00
" Received for eight copies proceedings sold (7 volumes, 2 and 1 vol. 1.)......................................		15 40
		$1,336 37
Cash paid out for sundries........................	60 90	
" " " " printing	631 15	
" " " " Rent of hall, last meeting.........	100 00	
" " " " Hoffman House parlor, last meeting	20 00	
" refund of initiation fee........................	5 00	
" Salary of Secretary and Treasurer...........	350 00	
	$1,167 05	
Cash balance on hand........................		$169 32

There are 189 names on the roll as members of the Association. Three of the 189 have died, viz.: Charles Collier, of Selma, Alabama, died in May, 1876; G. T. Sutton, of Peekskill Gas light Company, died in April, 1876, and W. H. Perry, of Bangor, Maine, died in May, 1877. The Peekskill Gas Light Company has written a letter to me, withdrawing from the Association. The Toledo Gas Light Company, has also notified me that it withdraws from the Association. Thomas W. Beatley, engineer of Peoples' Gas Light Company, of Brooklyn, whose name appears upon the roll, has notified me that he personally, never was a member of the Association; that he represented the Peoples' Gas Light Company, of which he was the engineer, and that the President, Mr. Edwin Ludlam, is now the member. Nineteen new members have been enrolled since the last report.

Mr. Chambers, Chairman of the Finance Committee, stated that the Committee had examined the Treasurer's report, together with the accounts and vouchers, and had found them correct. W. H. White moved that the report of the Finance Committee be received and accepted, which was carried.

REPORT OF TREASURER

OF THE

AMERICAN GAS LIGHT ASSOCIATION,

For the Year ending October 15, 1878.

CHARLES NETTLETON, *Treasurer*,

In account with AMERICAN GAS LIGHT ASSOCIATION.

1877.		Dr.			
Oct.	15.	To Cash balance on hand		$169	32
		" " of John W. Bates	1878	5	00
	17.	" " Miles W. Caughey, Initiation fee		10	00
		" " R. C. Terry,	"	10	00
		" " T. A. Bates,	"	10	00
		" " William Gibson,	"	10	00
		" " Gilliard Dock,	"	10	00
		" " C. E. Gray,	"	10	00
		" " L. Noble,	"	10	00
		" " H. T. Gerould,	"	10	00
		" " William A. Stedman,	"	10	00
		" " E. D. Moore,	"	10	00
		" " William Poland,	"	10	00
		" " F. M. Root,	"	10	00
		" " Thomas A. Cosgrove,	"	10	00
		" " H. Murphy,	"	10	00
		" " K. Murray,	"	10	00
		" " Joseph O. King,	"	10	00
		DUES FOR YEAR ENDING OCTOBER, 1878.			
		" " John Andrew		5	00
		" " Isaac Battin		5	00
		" " Fred S. Benson		5	00
		" " M. Cartwright		5	00
		" " H. F. Coggshall		5	00
		" " N. B. Crenshaw		5	00
		" " Henry Cartwright		5	00
		" " John Cartwright		5	00
		" " William Cartwright		5	00
		" " W. H. Denniston		5	00
		" " William Dunbar		5	00
		" " M. N. Diall		5	00

Oct.	17.	To Cash of		James R. Floyd		$5 00
		"	"	Theobald Forstall		5 00
		"	"	F. W. Gates		5 00
		"	"	L. P. Gerould		5 00
		"	"	A. G. Guerard		5 00
		"	"	William G. Gardiner		5 00
		"	"	C A. Gerdenier		5 00
		"	"	W. W. Goodwin		5 00
		"	"	L. C. Hanford		5 00
		"	"	William Helme		5 00
		"	"	George S. Hookey		5 00
		"	"	Joseph Hendly		5 00
		"	"	Thomas C. Hopper		5 00
		"	"	M. Harrington		5 00
		"	"	T. Littlehales		5 00
		"	"	J. Linton		5 00
		"	"	Edward Lindsley		5 00
		"	"	W. H. Linton		5 00
		"	"	W. H. McClelland		5 00
		"	"	J. McIlhenny	1876	5 00
		"	"	J. McIlhenny	1877	5 00
		"	"	J. McIlhenny	1878	5 00
		"	"	Emerson McMillan	"	5 00
		"	"	Richard J. Monks	"	5 00
		"	"	Lewis Moss	"	5 00
		"	"	W. H. Miller	"	5 00
		"	"	G. A. McIlhenny	"	5 00
		"	"	George B. Neal	"	5 00
		"	"	Charles Nash	"	5 00
		"	"	Peoples' Gas Light Co., Cleveland	"	5 00
		"	"	T. J. Pishon	"	5 00
		"	"	Samuel Prichitt	"	5 00
		"	"	W. H. Pearson	"	5 00
		"	"	Eugene Printz	"	5 00
		"	"	Willard Parritt	"	5 00
		"	"	Benjamin Rankin	"	5 00
		"	"	J. H. Rollins	"	5 00
		"	"	George Richardson	"	5 00
		"	"	James F. Rogers	"	5 00
		"	"	A. B. Slater	"	5 00
		"	"	James Somerville	"	5 00
		"	"	J. M. Starr	"	5 00
		"	"	James H. Smith	"	5 00
		"	"	Henry Stacey	"	5 00
		"	"	Thomas Turner	"	5 00
		"	"	C. White	"	5 00
		"	"	W. Henry White	"	5 00

Feb.	19.	To Cash of	Charles E. James	1878	$5 00
		" "	Copy volume 1. Sold	"	1 40
		" "	H. J. Reinmund	"	5 00
	23.	" "	Dorchester Gas Light Co	"	5 00
		" "	Edward L. Wood	"	5 00
	26.	" "	John Green	"	5 00
March	4.	" "	John C. Buxton	"	5 00
	12.	" "	Charles C. Van Benschoten	"	5 00
	20.	" "	F A. Sabbaton	"	5 00
	23.	" "	Charles Roome	"	5 00
April	8.	" "	W. H. Price	"	5 00
	18.	" "	Eli Butler	"	5 00
June	19.	" "	Copy volume 1. Sold	"	1 40
July	16.	" "	David W Crafts	"	5 00
Sept.	9.	" "	William M. Williams	"	5 00
		" "	Old paper sold	"	12
	17.	" "	Edwin Ludman	"	5 00
	18.	" "	W. H. Turner	"	5 00
		" "	W. H. Turner	1879	5 00
	19.	" "	B. E. Lehman	1878	5 00
		" "	Justus Dittman	"	5 00
	19.	" "	Hugh Murphy	1879	5 00
		" "	Charles S. Allmand	1878	5 00
	20.	" "	J. Desha Patton	"	5 00
	21.	" "	F. J. Davis	"	5 00
		" "	Henry Whitestone	"	5 00
		" "	Henry Whitestone	1879	5 00
		" "	George K. Reed	1878	5 00
	23.	" "	Moses Coombs	"	5 00
	25.	" "	Charles W. Isbell	"	5 00
Oct.	1.	" "	O. G. Steele	1879	5 00
	7.	" "	H. H. Sibley	1878	5 00
		" "	Hugh McLean	"	5 00
		" "	L. G. McCauley	"	5 00
	9.	" "	John S. Chambers	1879	5 00
		" "	J. M. Sterling	1878	5 00
		" "	I. N. Stanley	"	5 00
		" "	I. N. Stanley	1879	5 00
	11.	" "	Gideon Wood	1878	5 00
		" "	Gideon Wood	1879	5 00
	12.	" "	John W. Newell	1878	5 00
	14.	" "	George Buist	1879	5 00
		" "	J. Linton	"	5 00
		" "	W. H. Linton	"	5 00
		" "	F. M. Root	"	5 00
	15.	" "	E. McMillin	"	5 00
					$1,070 49

1877.			Cr.	
Oct.	15.	By Cash paid	telegrams	95
		" "	Stage fares	80
	24.	" "	3 quires wrapping paper	55
	25.	" "	Postage stamps	14 00
	26.	" "	Ball of twine	25
Nov.	3.	" "	Case, Lockwood & Brainerd Co., 100 copies of volume 2. proceedings printed for C. N.	47 06
1878.				
Jan.	28.	" "	Postal cards	1 00
Feb.	1.	" "	Postage stamps	2 00
	5.	" "	Postal cards	1 00
	8.	" "	Postage stamps	6 00
	27.	" "	A. M. Callender & Co., Bill printing, &c	3 90
March	1.	" "	Postage stamps	1 00
	7.	" "	Postage stamps	1 00
April	10.	" "	Postage stamps	1 00
May	8.	" "	Wrapping paper	88
June	24.	" "	Postage stamps	1 00
Sept.	16.	" "	Postage stamps	2 00
	21.	" "	Postage stamps	3 00
Oct.	7.	" "	Postal cards	2 00
	14.	" "	Salary one year, Charles Nettleton	350 00
	15.	" "	E. P. Coby & Co's Bill	6 50
			Balance to new account	624 60
				$1070 49

The undersigned have examined the accounts of Charles Nettleton, Treasurer, for the year ending October 15th, 1878, and find the same correct, with a balance due by the Treasurer of six hundred and twenty-four 60-100 dollars ($624 60.)

JOHN S. CHAMBERS,
JNO. P. HARBISON, } *Finance Committee.*
GEO. A. McILHENNY,